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NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

ECONOMIC PAPER No. 52

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NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

JOSEPH HYDE PRATT, Director

ECONOMIC PAPER No. 52

PROCEEDINGS

OF THE

ELEVENTH ANNUAL DRAINAGE CONVENTION

HELD AT

ELIZABETH CITY, NORTH CAROLINA
APRIL 12 AND 13, 1921

Compiled by

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

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LETTER OF TRANSMITTAL

CHAPEL HILL, N. C., June 1, 1921.

To His Excellency, HON. CAMERON MORRISON,

Governor of North Carolina.

SIR:—The Eleventh Annual Drainage Convention of North Carolina was held at Elizabeth City, April 12 and 13, 1921, under the auspices of the North Carolina Geological and Economic Survey and the North Carolina Drainage Association.

On account of the interest throughout this State in all matters relating to reclamation of our swamp and overflowed lands, it is believed that the papers presented at this Convention are of sufficient importance to warrant their being published with the proceedings of the Convention and distributed throughout the State. It is therefore recommended that the proceedings and all papers of this Convention be published by the Survey as Economic Paper No. 52 of the publications of the North Carolina Geological and Economic Survey.

Yours respectfully,

JOSEPH HYDE PRATT, *Director,*

North Carolina Geological and Economic Survey.

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Proceedings of the Eleventh Annual Convention of the North Carolina Drainage Association

Elizabeth City, North Carolina, April 12 and 13, 1921

TUESDAY, APRIL 12—Morning Session

Hon. John H. Small, President of the Association, Presiding.

The Eleventh Annual Convention of the North Carolina Drainage Association was opened in Elizabeth City, North Carolina, at 10:30 a.m., April 12, in the assembly room of the Chamber of Commerce, the meeting being called to order by the President, Hon. John H. Small. The session was opened with prayer by the Reverend J. M. Ormond of Elizabeth City, and addresses of welcome were delivered by Mr. J. C. B. Ehringhaus on behalf of the city, and by Hon. Walter L. Cohoon for the Chamber of Commerce.

Mr. Ehringhaus spoke as follows:

Elizabeth City is glad to have you here today. Elizabeth City welcomes you to her borders. We expect to derive a great deal of profit and pleasure from your stay among us, and we trust that when you shall go away you will carry with you a recollection of these hours and days spent with us, not only as having been full of profit from your associations here, but a pleasant recollection of this, the Queen City of the Albemarle section. We are given to boast a little today of our town. We take a pardonable pride in her position. It is the cradle of North Carolina; it is the center of all counties in Eastern North Carolina because it is so located geographically—this city of ours—that the adjoining counties naturally come to us as the center of their industrial and commercial activities. Elizabeth City boasts of many things, but she lacks a great many things; of that we are all sensible. And you, my friends, are welcome in our midst today because we recognize in your Association, and in you as members of that Association, men who have given of their time and efforts to a concerted effort to the better things of the State which we all love. We trust and believe that your stay here will be full of pleasure to yourselves, as well as profit. Anything in the world that the town owns and possesses is yours!

I was very much interested to find that this is the first visit of the Commissioner of Agriculture of North Carolina to Elizabeth City. I trust that it will not be his last, and I hope, too, that those of you who have not been here before will make it a point to come again. There is much for us both in continued associations.

Now, each and every citizen of this town bids you welcome, hopes you will feel at home among us—not as strangers, but as friends and brothers—and trusts that you will have a most enjoyable time while you are here.

The response to the addresses of welcome was made by Hon. John H. Small, President of the Association, who spoke as follows:

RESPONSE TO THE ADDRESSES OF WELCOME

The pleasure of responding to these very cordial addresses of welcome is emphasized by the fact that I not only express the individual sentiment of your presiding officer, but that I speak in a representative capacity for the members and delegates of the North Carolina Drainage Association. When a stranger comes to the home of a friend, his pleasure is much intensified if he has the glad hand of welcome extended to him and in cheery tones his host says, "Feel at home"; and when an association meeting from year to year in different cities convenes for a new meeting it is fitted better for the discharge of its duties because the membership is made contented and are pleased in spirit if a sincere welcome awaits them. We are confident that this welcome upon the part of the municipality and of this most active civic association, the Chamber of Commerce, are expressed in terms of sincerity, and, therefore, we are all the more appreciative.

I am in sympathy with what these gentlemen have said about Elizabeth City—first as to the fact that it is the northeasternmost town of any size in North Carolina, and because geographically it has for years been isolated from the remainder of the State. As a boy I recall when this railroad, now the Norfolk Southern, had been constructed only to Elizabeth City, how remote it was regarded by the people who lived even upon the south side of the Albemarle Sound, and how even in church affairs it was affiliated with another state rather than with its own State. Elizabeth City has been brought more nearly to the remainder of the State during these recent years by the extension of the railroad and by increased facilities of transportation by water, and now the proposed highway to Gates County, and thence to the balance of the State, affords a prospect of even better acquaintance.

But in spite of these handicaps, Elizabeth City has grown, and its growth has been distinctive. It is generally assumed that towns located near large cities are overshadowed and handicapped by their big neighbors. If any foundation ever existed for such a proposition, Elizabeth City has demonstrated its falsity. For three decades at least its growth has been steady and wholesome. In commerce, in manufactures, in the various organizations which make for religious and social betterment, it has constantly grown.

Agriculture, through the adoption of better methods and more intelligent supervision, has increased both in volume of production and quality of product; and I think it is fair to say that along with the remarkable rural and agricultural growth in North Carolina no section has shown a more marked progress than these counties in this northeastern section, which might be described as tributary to this metropolis of Northeastern North Carolina.

If Major Graham is making his first visit to Elizabeth City, and if any of you have that pleasure in common with him, you are to be congratulated that while the pleasure may have been postponed, the contentment which it brings to you and the discoveries which you make will at least justify the delay.

Speaking on behalf of the members and delegates of the Association, I again thank these gentlemen representing the municipality and the Chamber of Commerce for the very cordial and sincere words of welcome that they have extended us.

REPORTS OF OFFICERS

Report of the President

Following his response to the addresses of welcome, Mr. Small made his presidential address, as follows:

REVIEW OF RECLAMATION WORK IN NORTH CAROLINA

By Hon. John H. Small

Several thoughts, as you will observe after I have concluded, are prominent in my mind this morning in connection with the work of the Association: First, as to its accomplishments. I shall not detain you with a recital of the achievements of the North Carolina Drainage Association since its first meeting in the city of New Bern in 1908. Briefly stated, those achievements are the preparation and enactment of the drainage law, one of the most constructive pieces of legislation in the last two decades. The drainage law was prepared by a committee of your Association, of which your speaker was the chairman and in which he had a large part. It was the first modern drainage law in any southern state except Louisiana—and it is a compliment to this Association that since 1909 Virginia, South Carolina, Georgia, Florida, and Mississippi have enacted drainage laws substantially similar to the North Carolina law. The original drainage law in Louisiana was one which had existed for many years, founded upon the French code, as all Louisiana laws are; but it recognizes the outstanding principle in all modern drainage laws, the necessity for coöperation among various landowners whose lands may be drained to a common outlet.

About six hundred thousand acres of land in districts whose work has been completed have been reclaimed and thus added to the wealth of the State, increasing our productive capacity, adding to the taxable wealth, and constituting a very definite factor in the economic growth of North Carolina during this last decade.

But, with all that has been accomplished, there is still much to be done; in fact, we have only made a substantial beginning. There are yet many hundreds of thousands of acres of cutover swamp lands just as fertile as those which have been subjected to the plough, and which in the process of time and the spread of knowledge regarding the work of the drainage law and the profitable results from the drainage of these lands, will be added to the reclaimed area and bring additional wealth to the State.

The first thought which I desire to present and, in so far as I may, to emphasize, is the necessity of extending this drainage movement so that we shall begin the formation of drainage districts composed of cultivated lands. In this Coastal Plain section of the State with its low-lying level and slight elevation above tidewater—the oldest in the history of the development of the State—we have at the same time many hundreds of thousands of acres of cultivated lands, many of which have been cultivated for a hundred years, and some for a hundred and fifty years, which are uncertain in crop production because they have not been effectively drained; and they will never be efficiently drained by the invidual work of the owner. They cannot be drained except the water upon them is taken to some ultimate outlet. Such large outlet canal may cross the lands of a dozen or more farmers. The cost would be prohibitive for any one farmer. The only solution lies in coöperative effort under the provisions of the drainage law.

Having gone in and out among the homes of our people for many years, I speak from actual knowledge of the necessity for more effective drainage for the bulk of our cultivated lands. May I give you just one illustration which will strike a familiar note in your memory? I have heard my friends during May and June, and perhaps until the middle of July, report fine crops, with just enough sunshine and moisture for plant growth; and yet excessive rains would follow and they would report that their crops had been "drowned out." If I may make a rough calculation, I would say that the crops on many of these farms are destroyed or "drowned out" at least once in five years. Some of our best alluvial lands can only be relied upon for a full crop one or two years out of five. That is an unwise, unprofitable way in which to prosecute in any business; and we who know something of the benefits and necessity of drainage and the way by which it must be secured should make ourselves the ambassadors of progress and go among our people and preach to them the gospel of better drainage of their lands, and in doing so we will add immeasurably to their productive value, to the prosperity of the individual owners, and to the increased wealth of our State.

Ladies and gentlemen, what are some of the essentials for greater progress in drainage, as well as in some of the other economic movements in North Carolina? How may we obtain good roads; better schools; more commodious and progressive and consecrated churches; and better health conditions? How may we accelerate the movement for more and a better grade of livestock? What are some of the handicaps—and some of the essentials by which we may increase progress in these various movements?

First, as to the handicaps: One might suggest, first, a lack of intelligence and a prevalence of ignorance. The very first result of increased intelligence is the willingness and the capacity to recognize and admit our faults. The more ignorant a man is (and that applies to all of us), the more he is inclined to attribute his shortcomings and failures to some one else rather than to himself. The great bard expressed the thought that "It is not in our stars, but in ourselves, that we are underlings." A friend may criticise without offense, provided he is sincere. Ignorance is one of our serious handicaps which retards the movement for progress, whether spiritual or material.

There is a lack of mutual confidence among our people. A man ought to be wordly wise. To quote from the Good Book, he should be "as wise as a serpent and harmless as a dove"; but he should extend confidence where it is deserved.

The great bulk of these movements for progress require coöperation and confidence one toward another. We have emphasized in North Carolina too long a kind of self-conscious individualism. We need to broaden that into a spirit of service in which we shall be willing to consecrate a good part of ourselves and our hearts and minds to the cause of humanity and progress. And we cannot do that if we withhold confidence, because confidence is the basis of coöperation. I was talking recently to a wealthy man in the city of New York, and he said: "If you withdraw confidence from the financial and commercial affairs of the world, business would stop." Confidence must be extended where the recipient is worthy of confidence. Leadership of the kind that is blessed with intelligence and with the spirit of service and with a pleasing personality begets confidence. A leader of that kind in any community is more precious than gold, because his value cannot be expressed in dollars and cents. Where there is a consecrated leader of that kind, he ought to have, and is entitled to, the support of the good men and women of the community.

I must not detain you along this line for fear you may charge me with pessimism. I am not a pessimist. I am an optimist. But while following the bright light which the optimist loves to follow, we must not be blind to the

byways and hedges, but must endeavor to remove them. Let us in the spirit of intelligence and mutual confidence enlist more actively in the drainage of our wet lands. I think the Good Book says "Let him who would be great among you, be your servant," and no man has ever come to be great until he has learned to follow or to be a servant. Let us cultivate all of these qualities among our people, and the car of progress will be accelerated and the growth of our people and the welfare of the State will become a matter of pride to North Carolinians everywhere.

Ladies and gentlemen, may I present just this further thought: We need more people in North Carolina from the outside. This has been demonstrated in many ways, including this movement for the drainage of our wet lands. We have reclaimed more land which is now ready to be cultivated than we have home settlers to demand it. I have no prejudices against any man or his family from any other section. The only test I would apply would be as to his intelligence, character, and loyalty. If the selection rested with me I would rather favor settlers from New England, the Middle States, or the Mississippi Valley; but from whatever section they come, if they are good men who wish to make the best of conditions and help us build up, I would invite and welcome them. How may we obtain these people? Our activities in seeking immigration in the past have been sporadic and ineffective. I am almost inclined to the opinion that the best results can be obtained by private effort. I have great faith in organized real estate agencies.

We need more men, not only to make homes, but to become part of our citizenship. The infusion of new blood makes for the betterment of the stock and for greater economic development. We have an illustration right here in Elizabeth City. I cannot recall another town in North Carolina which has received more benefit from the settlement among it of substantial men and women from other states than Elizabeth City. They have made themselves a part of your citizenship. Elizabeth City is a conspicuous example of the good results that come from the introduction of a fine type of settlers.

In inducing these strangers here to settle among us, we must remember to do the things that will make them feel at home, and the only guide necessary is the golden rule—to do by them just as you would like to be done by if you moved to the State of Virginia, or any other state. Let them worship God just as they please, have their own political beliefs, and think and speak just as they please. Let them be free American citizens in every respect. In our churches, civic organizations, in the various social activities, let them be made to feel that they are a part and parcel of us; and if there is any good in them, they will respond to this treatment and make all the better citizens and a larger contribution to the common welfare.

Just this one thought in conclusion: Whose duty is it to make this drainage movement a success? Whose duty is it to keep moving this activity for better and greater length of highways? To provide better schools, both in our towns and rural communities? To get behind that most essential and protective movement for better health, and particularly in our rural sections? Whose duty is it to strive in everything that makes for better civilization; a better life in this world and a finer prospect for the future? Whose duty is it to seek for rural betterment? In that connection may I ask the privilege of saying a word to the men and women who live in the town? Every town in Eastern North Carolina has an interest in every farm in the State, and particularly those which are contiguous to and tributary to that town. So far in the future as we may peer, Eastern North Carolina is to be agricultural; farming will be its chief industry. We may add our manufacturing enterprises, and it is to be hoped we will; but the products of the soil of various kinds will for generations to come be larger in volume and value than all the

other products from every other source, and that means that Elizabeth City and every other urban community will be dependent upon the soil. It is the duty of the men and women who live in the towns, men and women of intelligence, men and women who have devoted some of their lives to service, to take an interest in these rural problems. It is no discredit to the rural community to say that the town has perhaps a broader intelligence, because in the past they have enjoyed better opportunities. The better equipped we are to serve, the greater is the obligation. The Good Book says "Of him to whom much is given, much will be expected," and whenever we are blessed with trained minds and strong bodies fitted for the daily task, we should consecrate these talents to human service. The man in the town is under obligation to work for the welfare of the man on the farm.

There are comparatively few of us gathered together at this meeting this morning, and yet we are among the elect; and though few in number, we can carry into the other sections of North Carolina the lessons which we will learn at this meeting of the North Carolina Drainage Association. I am sure that the meeting will be a success; I believe that each man will at the end be glad to say he has been benefited; and that you will go back to your homes strenghtened in your beliefs and purposes and determined to devote even more of your time to the cause of drainage in North Carolina, as well as to those other social and civic movements which make for the public welfare.

The President then called for the report of the Secretary and Treasurer.

REPORT OF THE SECRETARY

JOSEPH HYDE PRATT

The Tenth Annual Convention of the North Carolina Drainage Association was held at Washington, North Carolina, March 31 and April 1, 1920. The proceedings of this Convention have been published as Economic Paper No. 50 of the publications of the North Carolina Geological and Economic Survey, and this Economic Paper is herewith submitted and distributed as the Secretary's report of that meeting.

The Secretary desires to take this opportunity to sketch briefly the work that has been done in reclaiming our swamp and overflowed lands and to call attention to the problems that still confront the Association.

About fifteen years ago there were in the eastern part of North Carolina approximately 3,000,000 acres of swamp lands, and from 60 to 75 per cent of the remaining lands of the Coastal Plain region, although being used for farm lands, were low and wet, and consequently producing only about half crops. Soon after the reorganization of the North Carolina Geological and Economic Survey in 1905, which resulted in an extension of its duties, the problem of draining the swamp and flat lands of Eastern and the overflowed lands of Piedmont North Carolina was taken under consideration. One of the first projects undertaken by the Survey was the drainage of certain lands in Beaufort County. This project demonstrated that much of the swamp area of the State could be reclaimed, and would make good agricultural lands when reclaimed; but there were no adequate laws in the State that would warrant or permit individuals undertaking drainage projects except on a very small scale on their own farms.

Realizing these conditions, and also realizing what it would mean to Eastern North Carolina if these swamp areas were drained, the Director of the Geo-

logical Survey called a meeting of all interested persons in New Bern on September 9, 1908. At this meeting the many problems connected with drainage and reclamation work were discussed by the State Geologist, who presided at the meeting, by Senator Simmons, by Congressmen Small, Godwin, Thomas, and Ward, and by engineers from the United States Department of Agriculture, and others. As a result of this meeting, the North Carolina Drainage Association was organized and a recommended drainage law was drafted, which the General Assembly of 1909 passed without a single amendment. This law has proven most effective in North Carolina and has been adopted practically without change by Virginia, South Carolina, Georgia, Florida, and probably other southern states. The law has been amended in certain minor respects to overcome difficulties that could not be foreseen at the time of its passage. At the recent session of the Legislature an amendment was passed definitely declaring drainage districts political subdivisions of the State, so that now there can be no question about the exemption of drainage bonds from Federal income and other taxes. This amendment should strengthen the market for North Carolina drainage and reclamation bonds and thus give an added impetus to the already fine results achieved under the operations of this law.

MORE THAN ONE HUNDRED AND FIFTY PROJECTS

The North Carolina Geological and Economic Survey has largely had charge of the administration of this law. Under the drainage law more than 150 projects have been organized or proposed. Of this number, more than fifty have been districts embracing overflowed lands in the Piedmont section, including lands in Burke, Cabarrus, Catawba, Cleveland, Davidson, Forsyth, Gaston, Guilford, Iredell, Lincoln, Mecklenburg, Moore, Rockingham, and Rowan counties; more than one hundred have been districts in the Coastal Plain region, mostly swamp lands in Beaufort, Bladen, Camden, Carteret, Chowan, Columbus, Craven, Cumberland, Currituck, Duplin, Edgecombe, Harnett, Hyde, New Hanover, Onslow, Pamlico, Pender, Perquimans, Pitt, Robeson, Sampson, Tyrrell, Washington, Wayne, and Wilson counties. Of these projects, seventy-five districts have been completed; twenty have been approved; sixty-one have been proposed and are either in the preliminary stages of organization or are held up for one reason or another; while nine have been abandoned as not feasible at the present time. The most stupendous single project was the drainage of Mattamuskeet Lake, which embraced over 100,000 acres and had to be drained by pumping the water out, as the bottom of the lake was below sea-level. The Ohio banking house that drained the lake has the lake bottom now in a state of development. A model town is being built, roads constructed, and a part of the land is being made ready for cultivation. In all, more than $2,000,000 is being spent on the development of this one project.

INCREASED VALUE OF LANDS

Approximately 30,000 acres in the Piedmont region have been successfully drained. This land is now the best farming land in the Piedmont region and is worth from $100 to $200 per acre as against a value of from $20 to $25 per acre before drainage. This means an aggregate increase in the value of the reclaimed lands in the Piedmont section of the State of from $225,000 to $300,000, to say nothing of the added healthfulness and attractiveness of this region. In the Coastal Plain region over a half million acres of swamp lands have been drained which now have an average value of from $50 to $100 per acre as against a value of from 50c to $2.00 per acre before drainage, or an aggregate increase in value of from thirty to fifty million dollars.

The increased value of these reclaimed areas from a health standpoint would more than offset what it has cost to drain them; but, from a commercial point of view, this is the least benefit that has been derived. These reclaimed lands are now recognized as the richest lands in the State. They will grow almost any kind of crops without fertilizer, including corn, cotton, grain, hay, potatoes, and truck crops, and the yield per acre is without parallel. In certain sections specialized crops can be grown, as, for instance, strawberries in Pender and Columbus counties, where it is reported that this land is selling for as much as $1,000 per acre. Tobacco has been successfully grown on certain of these lands in other counties. Report comes from Beaufort County that one tract of reclaimed swamp land containing about 100 acres has been rented for the coming year for $100 per acre for growing potatoes. A recent communication in regard to New Hanover County Drainage District No. 1 states:

"This district has been completed about twelve months. Not only in an agricultural way are they reaping great rewards, but it has developed into a suburban territory. Homes are being built upon it. Already thirteen have gone up, each of which represents an expenditure of from two to four thousand dollars."

Part of a letter from the Big Cold Water District of Cabarrus County in Piedmont North Carolina reads:

"As much as seventy bushels of corn per acre have been raised on the drained lands of this district without fertilizer. From the health standpoint the drainage has been a remarkable success. Malaria and chills have decreased, so the doctors say, 75 per cent. . . . "

ACCESSIBILITY TO MARKETS

In addition to the fertile soil, the production of phenomenal crops, and the almost complete abolition of chills, malaria, and fever, these reclaimed lands have the advantage of being accessible to markets. With the development of a State system of highways such as is contemplated under the operations of the newly enacted law, a more ideal farming section cannot be found anywhere than right here in North Carolina on the swamp and overflowed lands that have been drained. Most of the lands that have been drained are as yet unsettled, and the question of how best to bring them to the attention of desirable homeseekers is one of the biggest problems following their drainage. This subject will constitute one of the chief topics for discussion at the coming convention.

MUCH YET TO BE DONE

Although the progress made in drainage and reclamation work in the State has been wonderful, yet there is still a great deal to be done. More than 2,000,000 acres of swamp lands in Eastern North Carolina yet remain undrained, of which at least 1,250,000 can be successfully drained and will make agricultural land as productive as that already under cultivation. The people in this region are proceeding with the work. Every few days requests come to the Geological and Economic Survey for information in regard to the formation of districts, in regard to methods of procedure under the drainage law, requesting that an engineer be appointed, and similar information. Only a few days ago an attorney for a district in Duplin County wrote:

"I am filing a petition in Duplin County for the drainage of Stewart's Creek and its tributaries. The district will be named 'Duplin County Drainage District, No. 2.' I am working up several other drainage districts, and will let you hear from me from time to time."

THE USE OF TILE

The subject of tile drainage has not yet received the attention that it merits. It is estimated that from 60 to 75 per cent of the lands now under cultivation in the Coastal Plain region, not counting the drained swamp lands, could be greatly improved as agricultural land by the use of tile. The fact that the land is too wet and that its drainage is inadequate is indicated by water standing on it after rains, by the hardening and cracking of the surface after it dries, by it breaking up into cakes and clods when ploughed, and by the growth of plants commonly found in wet places. More has not been done in the way of tile drainage because the lands can be cultivated as they are, and the farmers do not realize the significance of tile drainage or feel inclined to go to the expense that would necessarily be involved in putting it in. Tile drainage must be done largely by single individuals. It costs more per acre than the drainage of the swamp lands costs. However, the tiling of these low wet lands would at least double their productivity and at the same time greatly reduce the amount of labor necessary to cultivate them. The State Department of Agriculture is interested in tile drainage, and Commissioner Graham and one or two of his drainage engineers are at this convention to lead a discussion on this subject.

In addition to tile drainage and the bringing of desirable settlers to North Carolina to take up the reclaimed areas, the maintenance of drainage ditches and canals, and the marketing of drainage bonds, are problems that still confront the Association.

It is hoped that this brief sketch of the progress and results of reclamation work in North Carolina will serve to stimulate still more interest in the continuance of this great undertaking, and that, when published, it may possibly come to the attention of people outside the State who may be interested in taking up some of these lands.

The General Assembly of North Carolina of 1921 passed one amendment to the North Carolina Drainage act, as follows:

AN ACT TO AMEND CHAPTER 94 OF THE CONSOLIDATED STATUTES OF NORTH CAROLINA, ENTITLED "DRAINAGE."

The General Assembly of North Carolina do enact:

SECTION 1. That section 5312 of the Consolidated Statutes of North Carolina be and the same is hereby amended so as to read as follows: "The clerk of the Superior Court of any county in the State of North Carolina shall have jurisdiction, power and authority to establish levee or drainage districts, either wholly or partly located in his county, and which shall constitute a political subdivision of the State, and to locate and establish levees, drains or canals, and cause to be constructed, straightened, widened, or deepened, any ditch, drain or watercourse, and to build levees or embankments and erect tidal gates and pumping plants for the purpose of draining and reclaiming wet, swamp, or overflowed land; and it is hereby declared that the drainage of swamp lands and the drainage of surface water from agricultural lands and the reclamation of tidal marshes shall be considered a public use and benefit and conducive to the public health, convenience, utility, and welfare, and that the districts heretofore and hereafter created under the law shall be and constitute political subdivisions of the State, with authority as provided by law to levy taxes and assessments for the construction and maintenance of said public works."

SEC. 2. That section 5360 thereof be amended by adding at the end of said section the following words: "That the State having authorized the creation of drainage districts, and having delegated thereto the power to levy a valid tax

in furtherance of the public purposes thereof, it is hereby declared that drainage districts heretofore or hereafter organized under existing law or any subsequent amendments thereto are created for a public use and are political subdivisions of the State."

SEC. 3. That this act shall be in force from and after its ratification.

Ratified this 3d day of March, A. D. 1921.

In closing, I wish to call attention to the meeting of the National Drainage Congress, which will be held at St. Paul, Minnesota, September 22 to 24, and your Secretary would suggest that an attempt be made to make an exhibit at this Congress of what North Carolina has accomplished in reclamation work, and to show by photographs, maps, etc., the character of the land, what it will produce, and its relation to markets. It is believed that this is a splendid opportunity for advertising our reclaimed lands.

REPORT OF THE TREASURER

The report of the Treasurer, Joseph Hyde Pratt, was submitted, as follows, and referred to the Auditing Committee, who audited and approved the report:

FINANCIAL STATEMENT OF THE NORTH CAROLINA DRAINAGE ASSOCIATION

MARCH, 1920, TO APRIL, 1921

CR.

Balance on hand March, 1920	$ 4.42
Received from memberships	182.00

DR.

Paid to University Press for printing, April 9, 1920 (No voucher)	$ 10.00	
Paid to R. S. MacRae for postage, April 14, 1920 (Voucher No. 1)	20.00	
Paid to University Press for printing, May 4, 1920 (Voucher No. 2)	7.00	
Paid to National Drainage Journal for 52 subscriptions (Association membership), June 4, 1920 (Voucher No. 3)	78.00	
Paid to University Press for printing, April 1, 1921 (Voucher No. 4)	18.00	
Paid to R. S. MacRae for postage, April 7, 1921 (Voucher No. 5)	40.00	
	$173.00	$186.42
Balance on hand April 9, 1921	$13.42	
	$186.42	$186.42

Approved:

F. O. BARTEL,
W. W. PEIRCE,
Auditing Committee.

APPOINTMENT OF COMMITTEES

The President appointed the following committees:

Resolutions Committee:

C. W. Mengel, *Chairman*, Beaufort County.
H. M. Lynde, Wake County.
R. O. Bagley, Currituck County.
J. L. Becton, New Hanover County.
W. D. Alexander, Mecklenburg County.
R. L. Banks, Jr., Gates County.
W. M. Hinton, Camden County.
Thomas J. Nixon, Perquimans County.
Francis D. Winston, Bertie County.

Nominations and Next Meeting Place:

W. A. McGirt, *Chairman*, New Hanover County.
W. S. Pharr, Mecklenburg County.
B. M. Potter, Craven County.
W. W. Jarvis, Currituck County.
W. W. Peirce, Wayne County.
P. H. Johnson, Beaufort County.

Membership Committee:

R. K. Smith, *Chairman*, Norfolk, Va.
Miss Minnie Queen, Wilkes County.
Dr. Jas. L. Alexander, Mecklenburg County.
R. R. Cotten, Pitt County.
E. D. Winslow, Perquimans County.
W. A. Ellis, Gates County.

Auditing Committee:

F. O. Bartel, Wake County
W. W. Peirce, Wayne County

The chief subject considered at the morning session was farm loans, and this discussion was led by Hon. A. F. Lever, member of the Federal Farm Loan Board. Mr. Lever called attention to the fact that farmers should not remain the victims of speculators and go "broke" every two or three years; that the farmer produces two of the three things absolutely necessary to sustain life and civilization, and can command his own price for his products when once he determines to control those products and takes the control out of the hands of speculators. He also showed how the farmer can control the distribution and sale of his products; how he can secure a return for his labors that will make farm life so profitable and attractive that his children will prefer the farm to the city; and how the farmers of the Nation may pool their resources and finance themselves in any contingency. Mr. Lever's speech is given in full on page 28.

SPECIAL SESSION, 1:30 P. M.

CONFERENCE OF DRAINAGE ENGINEERS

COLONEL JOSEPH HYDE PRATT, Presiding.

At this conference, which was attended by twelve engineers interested in reclamation work in North Carolina, the following questions were discussed:

1. What is a drainage engineer?
2. Status of drainage engineers in North Carolina.
3. Relation of drainage engineer to preliminary examination of drainage district.
4. Should the State assist in making these preliminary surveys?
5. Would stream measurements be of value on certain of the rivers and streams running through these swamp areas?
6. Topographic maps.
7. Appointment of drainage engineers: Request of petitioners, clerk of court, organizer of district.
8. The act passed by the General Assembly of 1921 to regulate the practice of engineering and land surveying.

While the time for discussion of these subjects was limited, many interesting points were brought out by the different engineers, and the conference was considered well worth while.

AFTERNOON SESSION, 2:30 P. M.

HON. JOHN H. SMALL, Presiding.

The afternoon session was opened by an address by Mr. S. H. McCrory, Chief of Drainage Investigations of the United States Department of Agriculture, who spoke on the "Economic Value of Reclaimed Swamp Lands." He stressed one point which had not previously been brought out at meetings of the Association, which was that certain of our reclaimed swamp lands should be maintained in timber rather than cleared off for agricultural purposes. He showed that many thousands of acres of land in Eastern North Carolina were much more adapted for raising timber than for agricultural purposes.

Mr. W. D. Clark, of the Forestry Division of the North Carolina Geological and Economic Survey, followed Mr. McCrory with a paper on "The Relation of Forestry to Drainage." Mr. Clark's paper is given in full on page 33.

Major W. A. Graham, Commissioner of Agriculture, discussed the development and progress of agriculture in North Carolina, and commended highly the work of the North Carolina Drainage Association.

North Carolina State Library
Raleigh

Other speakers of the afternoon session were Judge Francis D. Winston, who made a very enthusiastic talk commending the work of the Association and calling attention to the fertility of the soil of Eastern North Carolina, which needed only to have its surplus water taken off to make it the most productive soil in the country; and Colonel Joseph Hyde Pratt, who spoke particularly of the need of establishment of drainage districts in Pasquotank County, and stated that the North Carolina Geological and Economic Survey would gladly coöperate with landowners in establishing such districts.

EVENING SESSION, 8:00 P. M.

Banquet at Southern Hotel

The banquet was given Tuesday evening at 8 o'clock by the citizens of Elizabeth City to the North Carolina Drainage Association was carried out under the auspices of the Elizabeth City Chamber of Commerce, of which Mr. Richard C. Job is the efficient secretary.

Mr. W. A. Worth was toastmaster, and very pleasantly and cleverly performed his duties, and in his informal talk calling the banquet to order made everybody feel at home, and from that time until the banquet was over there was a spirit of good fellowship prevailing and a freedom from restraint. For the special entertainment of the guests a double quartet from the Colored State Normal School at Elizabeth City sang old-time negro melodies, which were keenly appreciated by all. There were no long speeches, but the toastmaster called on several for short talks. Among those responding were Congressman John H. Small, Major W. A. Graham, J. M. Ferriss of Norfolk, Judge Francis D. Winston, C. Woodard of Wilson, W. O. Saunders, and Herbert Peele of Elizabeth City, and Colonel Joseph Hyde Pratt. The following is a report of the talks as made by the *Elizabeth City Daily Advance:*

The theme of Mr. Small and Mr. Ferriss was the same: The advantages enjoyed by Eastern North Carolina as compared with other sections of the United States.

"If I were a young man," said Mr. Small, "I would as soon settle in this section and undertake here to carve out my fortune as in any section of the continent—and I have traveled in almost every region of the Union and in many parts of the American continent besides."

Mr. Small also took occasion to congratulate Elizabeth City on its growth and development, on its thriving Chamber of Commerce, on its coöperative community spirit, and to express the appreciation of the Association for the handsome fashion in which Elizabeth City had played host to the convention.

Mr. Ferriss, born in the West, traveled all over the Union, a student of farming conditions wherever he had been, spoke in glowing terms of the advantages of this section in the fertility of its soil, which he said compared favorably with that of the delta of the Nile, in unsurpassed climate with three times the growing season of Minnesota, in its abundant rainfall and in its nearness to the great consuming centers. In these latter respects he compared

it to the prairies, to the more southern states, and to the extreme western states. Some of these, he pointed out, are subject to prolonged droughts which sometimes utterly destroy the crops. Others are subject to disastrous floods which inundate the land and sweep away millions of dollars worth of wealth. None of them can so easily reach the great consuming centers. Our needs, he said, are drainage and transportation.

Colonel Pratt talked of linking up the section with North Carolina by two great highways, one to Wilmington and one to Raleigh, and he believed that such outlets for this section would be in course of construction in the very near future. He said that Elizabeth City's truly remarkable growth and progressive spirit, under the conditions that have prevailed and the handicaps that have been imposed by lack of good roads and of adequate drainage, is an index of what may be expected of this city and section when these handicaps have been removed. He ventured the prediction that the next time the Drainage Convention meets in Elizabeth City many of the delegates from all sections of the State will come by automobile instead of by the Norfolk Southern.

Covers were laid for one hundred guests, and precisely that number were present. From the standpoint of the menu and service the banquet, the first served at the Southern under the present management, was as pronounced a success as in other respects.

WEDNESDAY, APRIL 13, 10 A. M.—Morning Session

HON. JOHN H. SMALL, Presiding.

At the opening of the session the Secretary read the following letter from Mr. Henry C. Wallace, Secretary of Agriculture, and telegram from Mr. Mark W. Potter, Commissioner of the Interstate Commerce Commission:

THE SECRETARY OF AGRICULTURE
WASHINGTON

MARCH 23, 1921.

DEAR MR. PRATT:

I am in receipt of your letter of March 21, and thank you for the invitation to be in Elizabeth City, North Carolina, to attend the annual convention of the North Carolina Drainage Association on April 12 and 13.

In view of other engagements already made, I regret to advise you that I cannot give you a favorable reply. I shall hope, however, to be able to visit your section of the country some time in the near future.

Very truly yours,

(Signed) HENRY C. WALLACE.

MR. JOSEPH HYDE PRATT,
Secretary, North Carolina Drainage Association,
Chapel Hill, North Carolina.

WASHINGTON, D. C., April 11, 1921.

HON. JOHN H. SMALL,
Drainage Conference, Elizabeth City, N. C.

Regret impossible to attend drainage conference. Matters of exceptional importance require my presence here.

(Signed) MARK W. POTTER.

The first speaker was Mr. W. A. McGirt, manager of the North Carolina Landowners' Association, who spoke on "Eastern North Carolina: Its Commercial Development." Mr. McGirt stressed the importance of drainage as an essential in the development of Eastern North Carolina, and urged business men to devote more of their time to the drainage problem and other questions so vital to the future of this section. The speaker stated that he would not hesitate to compel the children of our public schools to study the problems of our Coastal Plain, if he had the power to do so, that these children, after they reach maturity, might understand the handicaps that are retarding our development, and proceed to remove them.

The next speaker was Mr. C. G. Elliott, consulting engineer of Washington, D. C., who was formerly Chief of Drainage Investigations of the United States Department of Agriculture, and has been closely identified with drainage work in North Carolina since its beginning. Mr. Elliott spoke on "Some Features of Drainage and Land Development." His was a very interesting and instructive paper, and is given in full on page 36.

Mr. R. K. Smith of Norfolk, representing the Roper Lumber Company, who have organized several drainage districts in the Albemarle area, made a short but interesting talk on the work of the company and the value of the reclaimed lands and the probability of the area becoming the greatest agricultural section of the South.

The next subject discussed was Tile Drainage. Mr. H. M. Lynde, of the United States Department of Agriculture, led the discussion, and he was followed by D. C. McCotter, of Cash Corner; Mr. A. S. Cline, Assistant Director of the Drainage Experiment Station of the North Carolina Department of Agriculture at Wenona; Mr. L. W. Shook, manager of the Cotton Valley Farm at Tarboro, and Mr. F. P. Latham, owner of the Circle Grove Farm at Belhaven, all of whom made very interesting and instructive talks. Their papers are given in full on pages 42-47.

The last address of the convention was made by Dr. T. H. D. Griffitts of the United States Public Health Service, who spoke on the general subject of Drainage versus Mosquitoes and Malaria. His paper is given in full on page 47.

The convention was then thrown open for consideration of any question which any of the members wished to bring up. In reply to a question regarding drainage in the Piedmont section of the State, Mr. W. D. Alexander, drainage engineer, of Charlotte, N. C., gave a very instructive and interesting résumé of what had been accomplished in Mecklenburg County and the elimination of malaria in the Charlotte district by drainage of the overflowed lands. Mr. Alexander has been connected with a great many of the Piedmont drainage districts, and stated that in all cases the people had been extremely pleased with the results obtained in the reclamation of their overflowed lands.

Mr. H. E. Ownley, of Chapanoke, R. No. 1, raised the question of how to start a drainage district in his section of Pasquotank County. He stated that he believed the people were interested in the reclamation of their swamp lands and were ready to assume the obligation of the cost of the drainage if some one would show them how to proceed and let them know definitely whether the drainage was feasible. In reply to Mr. Ownley, the State Geologist stated that the Survey would coöperate with the people, and Mr. McCrory, in charge of drainage investigations of the United States Department of Agriculture, stated that his department would also assist those people in making a preliminary examination. Mr. Ownley's request for such assistance was carried out and a preliminary report made. This is given on page 65.

Another question raised was how to bring settlers to take up the reclaimed lands. One of the delegates called attention to the fact that there was a vast difference in selling the reclaimed lands and in settling those same lands. It seemed to be the consensus of opinion that there was a large field of work for the Department of Agriculture and the State Survey to assist in advertising these reclaimed lands and call to the attention of those seeking agricultural lands the advantages of fertility, nearness to market, and transportation facilities of these black-soil lands of Eastern North Carolina.

The State Geologist called attention to a communication he had had from Mr. Mark W. Potter of the Interstate Commerce Commission, who is a large landowner in Eastern North Carolina, in regard to describing these lands; that in calling attention to them, instead of speaking of them as "reclaimed swamp lands," we ought to give them a name that indicates what they are, and suggested "the black-soil lands of Eastern North Carolina."

At the suggestion of the President, the convention decided to continue the morning session through the noon hour and until all business of the convention had been completed.

The President then called for the reports of the several committees.

The report of the Committee on Resolutions was read by Mr. C. W. Mengel, chairman, and was as follows:

REPORT OF THE COMMITTEE ON RESOLUTIONS

The North Carolina Drainage Association, assembled in this the Eleventh Annual Convention, may view with a pardonable pride its records of achievement during the past fifteen years.

North Carolina's activities in drainage are known far and wide, and the rich soils made available by drainage are in demand far beyond the confines of the State. In spite of this progress, however, some older cultivated sections are lagging behind in this movement, and upon these we urge the necessity of falling in line and reaping the sure reward to be gained through drainage.

Since this Drainage Association may be well called the pioneer in a series of progressive moves in our State which culminated in acts of the past Legislature: Therefore, be it

Resolved, That this Association extend its congratulations to the Governor of North Carolina and to the members of the General Assembly of 1921 for the liberal contribution to the progress of the State embodied in the passage of appropriations for good roads, education, health, welfare, and agriculture. The unanimity of action in matters of such broad interior argues well for the State's future progress.

Resolved, That the thanks of this Association are tendered to the officers of the Association for the planning of this most excellent program, and to the speakers who have offered such instructive suggestions and advice.

Resolved, That this Association commend the coöperative work being done by the Drainage Division of the Bureau of Public Roads, U. S. Department of Agriculture, and the North Carolina Department of Agriculture. The pioneer work being done in the tile drainage field and in terracing is worthy of highest praise.

Resolved, That this Association does hereby tender its thanks to Mr. C. G. Elliott, not only for his presence and constructive address at this meeting, but also for past valuable assistance rendered the cause of drainage in this State and the Nation.

Resolved, That we urge upon the next General Assembly the necessity of providing the North Carolina Geological and Economic Survey with funds to carry on investigations and distribute data obtained in stream flow throughout the State. This information is badly needed by the drainage engineers of the State.

Resolved, That this Association urge upon drainage engineers the necessity of recording for future use all data collected for drainage districts, and that such data be recorded with the Geological and Economic Survey so as to link with other surveys in the State, thus aiding in the enormous task of finally completing a topographic map of this State.

Resolved, That the thanks of the Association are tendered the Chamber of Commerce and the citizens of Elizabeth City for their cordial reception and genial hospitality offered and for the splendid arrangements made for the accommodation of the delegates during their stay here, and to the newspapers for their hearty coöperation in advertising and reporting the convention.

Resolved, That the thanks of the Association be tendered its President, Hon. John H. Small, not only for his abiding interest in drainage but also for his continued devotion to all matters relating to the welfare of the citizens of the State.

Resolved, That this Association offer felicitations to its Secretary, Colonel Joseph Hyde Pratt, in his first appearance before it in a number of years. It is our wish that we may long have available his splendid counsel and assistance.

Respectfully submitted,

C. W. MENGEL, *Chairman*;
H. M. LYNDE,
R. O. BAGLEY,
J. L. BECTON,
W. D. ALEXANDER,
T. J. NIXON,
W. M. HINTON,
R. L. BANKS, JR.

The report of the committee was approved and, on motion being made and seconded, the resolutions were adopted as read.

The convention unanimously extended a vote of thanks to Mr. C. G. Elliott for his thoughtful and carefully prepared paper.

REPORT OF COMMITTEE ON NOMINATIONS AND NEXT MEETING PLACE.

The report of the Committee on Nominations and Next Meeting Place was read by Mr. W. A. McGirt, as follows:

Nominations:

For President, HON. JOHN H. SMALL, Washington.
For First Vice-President, J. E. SHEPARDSON, Belhaven.
For Second Vice-President, H. M. LYNDE, West Raleigh.
For Secretary-Treasurer, JOSEPH HYDE PRATT, Chapel Hill.

Members of the Executive Committee:

HON. JOHN H. SMALL, *ex-officio*, Chairman;
C. W. MENGEL, Beaufort;
W. D. ALEXANDER, Mecklenburg;
B. M. POTTER, Craven;
W. W. PEIRCE, Wayne;
P. H. JOHNSON, Beaufort;
I. C. HENDERSON, Onslow;
R. L. BANKS, JR., Gates;
R. O. BAGLEY, Currituck;
WALTER L. COHOON, Pasquotank.

The report of the committee was accepted and, on motion duly made and passed, the Secretary was instructed to cast a ballot for the nominees as submitted by the committee. The Secretary cast the ballot and declared the nominees elected.

Next Meeting Place: The following telegram from Goldsboro was read by Mr. McGirt:

GOLDSBORO, N. C., April 12, 1921.

President Drainage Convention, Elizabeth City, N. C.:

We extend to you a most hearty invitation to hold your next annual convention in our city. We assure you that if you meet in Goldsboro we shall do all in our power to make your organization successful. Goldsboro, as you know, is a railroad center and can be reached conveniently from every section of the State.

Yours for service,

(Signed) THE GOLDSBORO CHAMBER OF COMMERCE,
W. C. DENMARK, *Secretary.*

8:27 A.M., April 13.

After reading the telegram, Mr. McGirt reported that the committee recommended unanimously that the next convention of the North Carolina Drainage Association be held at Goldsboro, Wayne County. Before taking action on the recommendation of the committee, Major W. W. Peirce of Goldsboro made an impressive talk regarding the advantages of Goldsboro for holding the convention and urged the convention to adopt the committee's recommendation.

On motion duly made and seconded, the convention unanimously adopted the committee's report and selected Goldsboro as the next meeting place of the convention.

Report of Membership Committee.

The report of the Membership Committee was read by the chairman, Dr. J. L. Alexander, as follows:

It is the sense of the Committee that, in the interest of an increased membership in the Association, the dues be reduced to one dollar ($1.00) per year for membership fee, so that all may join.

Respectfully submitted,

J. L. Alexander, *Chairman;*
R. K. Smith,
R. R. Cotten,
E. D. Winslow,
W. A. Ellis,
Miss Minnie Queen,
Membership Committee.

Upon motion duly made and seconded, the report of the committee was unanimously adopted.

The convention adjourned *sine die* at 2 p. m.

The delegates remaining over in Elizabeth City, Wednesday afternoon, were given an automobile ride to Weeksville over some of the good roads of Pasquotank County. Those furnishing automobiles for the delegates were: J. T. McCabe, W. J. Woodley, Camden Blades, Dr. A. L. Pendleton, M. W. Ferebee, C. O. Robinson, and C. A. Cooke. A score of other automobiles were offered, and Secretary Job, if he had asked for them, could have had every automobile in the city not used strictly for business.

DELEGATES REGISTERED AT ELEVENTH ANNUAL CONVENTION NORTH CAROLINA DRAINAGE ASSOCIATION, ELIZABETH CITY, APRIL 12 AND 13, 1921.

Beaufort County:

Dodd, J. G. ..... Belhaven, N. C.
Johnson, P. H., Pantego Drainage District ..... Pantego, N. C.
Latham, F. P. ..... Belhaven, N. C.
Mengel, C. W., Drainage Engineer ..... Belhaven, N. C.
Small, John H. ..... Washington, N. C.
Wilkinson, J. A. ..... Belhaven, N. C.

Bertie County:

Evans, J. C. ..... Windsor, N. C.
Winston, Judge Francis D. ..... Windsor, N. C.

Brunswick County:

Babson, M. F. ..... Ash, N. C.

Camden County:

Burgess, H. B. ..... Old Trap, N. C.
Burgess, J. M. ..... Old Trap, N. C.
Cuthrell, F. C. ..... Camden, N. C.
Hinton, W. M. ..... Shiloh, N. C.
Toxey, M. N. ..... Shiloh, N. C.

Chowan County:

Griffin, E. J. ..... Edenton, N. C.

Craven County:

Potter, B. M., Drainage Engineer ..... New Bern, N. C.

Currituck County:

Bagley, R. O. ..... Moyock, N. C.
Cox, D. A. ..... Moyock, N. C.
Graves, W. G. ..... Moyock, N. C.
Jarvis, W. W. ..... Moyock, N. C.
Tate, W. J. ..... Moyock, N. C.

Gates County:

Banks, B. L., Jr. ..... Gatesville, N. C.
Blanchard, Rufus ..... Trotville, N. C.
Derby, W. B. ..... Gates, N. C.
Ellis, W. A. ..... Gatesville, N. C.
Willey, J. F. ..... Gates, N. C.

Hyde County:

Clayton, John M. ..... Engelhard, N. C.
Gibbs, Theodore ..... Scranton, N. C.

Mecklenburg County:

Alexander, Dr. Jas. R., Mecklenburg Drainage Comr.....Charlotte, N. C.
Alexander, W. D., Drainage Engineer.....Charlotte, N. C.
Knox, J. M., Drainage Commissioner.....Huntersville, N. C.
Pharr, W. S., Drainage Commissioner.....Charlotte, N. C.
Wolfe, C. H., Jr., Drainage Commissioner.....Charlotte, N. C.

New Hanover County:

Becton, J. L., Drainage Engineer.....Wilmington, N. C.
McGirt, W. A., Mgr. N. C. Landowners Association.....Wilmington, N. C.
Sprecken, F. von, Drainage Engineer.....Wilmington, N. C.

Onslow County:

Henderson, F. C.....Maysville, N. C.

Orange County:

Pratt, Jos. Hyde, State Geologist.....Chapel Hill, N. C.
Clark, W. D., Chief Forest Fire Warden.....Chapel Hill, N. C.

Pamlico County:

Cowley, H.....Cash Corner, N. C.

Pasquotank County:

Bell, C. D.....Elizabeth City, N. C.
Boettcher, Mrs. Sallie.....Elizabeth City, N. C.
Brite, E. C.....R. F. D. No. 6, Elizabeth City, N. C.
Brite, J. R.....Elizabeth City, N. C.
Brock, C. H.....Elizabeth City, N. C.
Brothers, F. W.....Elizabeth City, N. C.
Brothers, W. W.....Elizabeth City, N. C.
Carver, Harry L.....Elizabeth City, N. C.
Chappell, R. O.....Elizabeth City, N. C.
Clarke, Geo. W.....Elizabeth City, N. C.
Cohoon, Walter L.....Elizabeth City, N. C.
Cooke, C. A.....Elizabeth City, N. C.
Crawley, Capt. R. T.....Elizabeth City, N. C.
Falls, G. W.....Elizabeth City, N. C.
Foreman, J. W.....Elizabeth City, N. C.
Foster, W. A.....Elizabeth City, N. C.
Gaither, Chas. W.....Elizabeth City, N. C.
Gaither, W. G.....Elizabeth City, N. C.
Granger, E. D.....Newland, N. C.
Gregory, W. J.....Elizabeth City, N. C.
Hall, John H.....Elizabeth City, N. C.
Hinton, W. M.....Elizabeth City, N. C.
Hite, Capt. M. P.....Elizabeth City, N. C.
Jennings, A. J.....Elizabeth City, N. C.
Lowry, F. W.....Elizabeth City, N. C.

Pasquotank County—continued.

Meads, A. A.....Weeksville, N. C.
Moran, J. Sterling.....Elizabeth City, N. C.
Neal, A. S.....Elizabeth City, N. C.
Ormand, Rev. J. M.....Elizabeth City, N. C.
Ownley, H. E.....R. F. D. No. 1, Chapanoke, N. C.
Ownley, T. S.....Chapanoke, N. C.
Perry, J. W.....Okisco, N. C.
Pritchard, W. F.....Elizabeth City, N. C.
Saunders, W. O.....Elizabeth City, N. C.
Sawyer, D. E.....R. F. D. No. 4, Elizabeth City, N. C.
Scott, S. W.....Weeksville, N. C.
Seeley, Harry M.....Elizabeth City, N. C.
Sharber, J. G.....Elizabeth City, N. C.
Sharber, W. D.....Elizabeth City, N. C.
Simpson, J. F.....Chapanoke, N. C.
Spence, B. F.....Elizabeth City, N. C.
Temple, D. C.....Elizabeth City, N. C.
Toxey, A. F.....Elizabeth City, N. C.
Twiford, D. C.....Elizabeth City, N. C.
Wilkins, J. H.....Elizabeth City, N. C.
Williams, J. N.....Elizabeth City, N. C.
Williams, Jno. T.....Elizabeth City, N. C.
Williams, W. J.....Elizabeth City, N. C.
Wood, J. Q. A.....Elizabeth City, N. C.
Woodley, W. J.....Elizabeth City, N. C.

Perquimans County:

Cox, David.....Hertford, N. C.
Nixon, Thos. J., Jr.....Hertford, N. C.
White, W. E.....Hertford, N. C.
Winslow, E. D.....Hertford, N. C.
Winslow, T. F.....Hertford, N. C.

Pitt County:

Cotten, R. R.....Bruce, N. C.

Tyrrell County:

Swain, Hon. H. L.....Columbia, N. C.

Wake County:

Andrews, Melvin, with *Progressive Farmer*.....Raleigh, N. C.
Bartel, F. O., Drainage Engr., N. C. Dept. of Agriculture.....Raleigh, N. C.
Graham, W. A., Commissioner of Agriculture.....Raleigh, N. C.
Joyner, Andrew.....Raleigh, N. C.
Lynde, H. M., Drainage Engineer.....Raleigh, N. C.
Welch, Wm. J., with *Progressive Farmer*.....Raleigh, N. C.

Washington County:

Cline, A. S.....Wenona, N. C.
Martin, Van B.....Plymouth, N. C.
Temple, N. M.....Wenona, N. C.

Wayne County:

Peirce, Wentworth W.....Goldsboro, N. C.

Wilkes County:

Queen, Miss Minnie.....North Wilkesboro, N. C.

Wilson County:

Woodard, C.....Wilson, N. C.

Out-of-State Delegates:

Thompson, M. W., Thompson & Mosley, Inc.....Atlanta, Ga.
Severn, B. D.....Atlantic City, N. J.
Ferriss, J. M.....Norfolk, Va.
Griffitts, Dr. T. H. D., U. S. Public Health Service.....Norfolk, Va.
McKinney, F. W.....Norfolk, Va.
Portlock, F. L.....South Norfolk, Va.
Smith, R. K., Norfolk Southern Land Company.....Norfolk, Va.
Widgeon, J. M.....Norfolk, Va.
Wright, T. J., Jr.....Norfolk, Va.
Parker, J. V.....Portsmouth, Va.
Fuller, Frank L.....Richmond, Va.
Elliott, C. G.....Washington, D. C.
McCrory, S. H., U. S. Department of Agriculture.....Washington, D. C.

PAPERS DELIVERED AT THE ELEVENTH ANNUAL DRAINAGE CONVENTION.

FARM LOANS

By Hon. A. F. Lever, Member Federal Farm Loan Board

The question uppermost in the minds of farmers is what has happened to bring about the present situation with respect to the value of farm products; what has occurred to justify a slump in prices of farm products ranging from 50 per cent to 100 per cent within a period of twelve months. Certainly there are no less mouths to be fed now, or bodies to be clothed now, than there were twelve months ago. The yield of farm products for the year 1920 was not unusually large. The need for such products has undoubtedly kept pace with the supply of them. This being true, the inquiry as to the cause for the slump in prices of farm products becomes all the more important and interesting.

THE DEMAND FOR FARM PRODUCTS NEVER GREATER THAN NOW

There are tens of thousands of men, women and children throughout the world who are on the veritable verge of starvation and who are moving from place to place clothed in rags. There are more of this unfortunate class of people now than there were a year ago, which would suggest to the student of economy that the value of things to eat and with which to clothe the body should be higher than in 1920; and to find the reverse of it, presents a line of study which must develop the discovery of certain broad principles which govern in the determination of prices.

PLENTY OF DEMAND BUT LACK OF MONEY OR CREDIT.

The very first thing that we come in contact with in the study of the problem is the fact that there is an unusual demand for farm products throughout the world but there is a lack both of money and credit with which to make good the demand. The starving children of Armenia need your wheat and corn and livestock, but they have nothing with which to pay you for it. The cotton factories of France, Germany, Austria, and Russia could, if put into operation, make heavy inroads into the six million bales of surplus cotton now held in the South, but the difficulty here again is that the market of Germany, Austria, and Russia are closed to the cotton producer, while the difference in exchange rates makes it almost impossible for the factories of France to buy the raw material, manufacture and sell it in competition with American manufacturers and make a profit.

The domestic consumer of farm products is on a buyer's strike. He is refusing to buy at the exhorbitant prices demanded by some retailers, except as he must buy to meet immediate needs. This, of course, results in a lessened domestic demand which reflects itself in prices.

The domestic manufacturer, the wholesaler and the jobber, because of the uncertainty of the price of the raw material and the demand for the finished product, are, as it were, dancing the hesitation dance, and they too are in the market only to fill immediate demands.

RESTORATION OF CONFIDENCE.

The problems and difficulties of agriculture at this moment are fundamental in character. They cannot be solved by the application to them of expedience or nostrums. The trouble is deep seated and requires a major operation. It

cannot be cured by the application of poultices and salves. The knife of the surgeon is necessary. The patient is mighty sick but he is more frightened than sick, and before we can hope to get him in a position to apply the remedy which will cure him, we must first convince him that he is not nearly so sick as he is scared. In these critical times there is no place for the pessimist. This great country of ours is not headed in the direction of the "dimnition of bow-wows." A nation which can mobilize within two years thirty billions of wealth, arm and equip five millions of boys and send two millions of these across the water to fight on foreign shores is not going to fail to arise to this emergency and to meet it and overcome it. The one big immediate need of this hour is the restoration of confidence in all classes of people in the future of our country, coupled with a resolution that we are going to think and act in the light of the sun and not in the gloom of the darkness. The situation may be likened to a flock of wild geese that has been disturbed unexpectedly by the hunter. They are flying pell mell in every direction, each individual looking out for itself. But this will not continue long because pretty soon you will see the flock lining out in proper formation under the leadership of one who knows his business and destination. We need only some leadership, some stepping out as it were, in the direction of a return to normal, in order that the whole flock of us may begin to set ourselves in the same direction. And when this happens, manufacturing will begin, the jobber and the wholesaler will set their machinery in motion, retailers will take on new courage and hope, and all of these things will reflect themselves in a better agricultural situation. In the meantime, it is to be hoped that foreign markets will begin to right themselves with the aid of credit corporations formed in this country under the provisions of the Edge Act and with the help of the recently restored War Finance Corporation.

OUT OF THE GLOOM—LEARNED WHOLESOME LESSONS.

But from the viewpoint of agriculture the mere restoration of confidence is not going to furnish a permanent solution of its problems. There are difficulties that require for their remedying the concerted action of the states and the nation as well as the farmers themselves.

THE FACTS.

When it is demonstrated by the fact that the country teacher, the country preacher, and the farmer receive the lowest scale of wages of any class of our population, it must be admitted that there is something fundamentally weak in the system under which agriculture is operating. The existing system has not only eventuated in the fact just mentioned, but it is responsible for the fact—

(a) That, more than one-third of our farm population is tenant. This means absentee landlordism, or to express it more accurately, inefficient farming and unwholesome rural conditions.

(b) That, not over twenty per cent of our farm homes have in them either running water—the burden lifter of the housewife—or artificial lights; the average daily labor of the average farm woman is from twelve to thirteen hours.

The isolated life of the average farm woman presents the amazing and indefensible tragedy of American life. The farm woman is the crux of the rural problem. When she is happy and contented with her surroundings, you will find her boys and girls likewise to be happy and contented, but it is the revolt of these boys and girls against the life of drudgery which their parents lead that has resulted in the increasing drift of the population from country to town, resulting, as disclosed by the present census for the first

time in our history, in there being a larger per cent of people in towns and cities than there are in the country. It may sound ridiculous, and by the unthinking be called foolish, to venture the assertion that Henry Ford in supplying the world with a cheap, quick method of transportation, is exerting upon rural life a more profound influence than has ever been exerted upon it by any man living or dead.

(c) That, the farmer is without effective voice in the determining of the price of his products.

(d) That, as a result of this condition, the average farmer of Missouri will not realize from his 1920 crop more than sufficient to pay his taxes and the interest upon his capital investment.

WHAT CAUSES HAVE LED TO SUCH A SITUATION?

What have been the underlying causes resulting in such an unwholesome condition?

(a) The farmer has been taught to walk the furrow and produce, and per capita he is the best producer in the world. We have taught him to become an expert with his hands and have left him as a child in the use of his head in the management of his affairs other than production.

(b) The farmer has never regarded himself, nor have the people, anything but a producer. He is more than that. He is a manufacturer, and a merchant as well. It would not be wise, in my judgment, for him to undertake in himself to become a merchant. Of course, he cannot escape being a manufacturer. It is wise, however, not only wise but absolutely essential, to his prosperity that he should organize commodity sales agencies with expert salesmen to do the selling for him and this should take into account both domestic and foreign business.

(c) For the great staple crops like wheat, corn, cotton, wool, and livestock, there is no existing machinery for the orderly marketing of farm products.

(d) Agriculture is both under-capitalized and is without any adequate system of credits adapted to its peculiar needs.

THE SYSTEM RESULTS IN—

(a) The terrific strain upon the finances of the country at the crop moving season.

(b) An inefficient and expensive system of transportation.

(c) An uneconomic and unwise strain upon the buying and absorptive powers of the purchasers of farm products. Under this system we are asking the buyers of farm products to meet their needs for a period of twelve months in a period of from four to five months, with the inevitable result to the seller of these products.

(d) The system forces the farmer to sell in four or five months of the year from seventy-five to eighty per cent of that which it has taken him twelve months to prepare for—seed, cultivate and prepare for market, with the resultant autumnal dip in the price of farm products.

THE COSTS OF INEFFICIENCY OF SYSTEM ALWAYS CHARGED AGAINST THE FARMER.

It must be understood in this discussion that all costs anywhere along the line, chargeable to the inefficient system under which the farmer operates, are always chargeable against the farmer. If there are expensive methods of transportation of farm products from farm to market, the expense falls upon the farmer's product; if railroad rates are high or if railroad facilities are inadequate to meet the autumnal crop movement, with the result that wheat and corn lie rotting on the side tracks, these expenses are charged

against the farmer; if oceanic rates are high because of any inefficiency of the system, the difference between such rates and rates under an efficient system is charged against the price of the farmer's products. If there is any lack of credit facilities which if existing would enable the farmers not only to produce less expensively but to sell more intelligently and at a larger profit, here again the difference is chargeable to the farmer.

The matters which we have just discussed are not of a temporary character. They are permanent, inherent, and fundamental, and nothing save fundamental remedies will reach them. The remedies which suggest themselves to me are:

(a) The elimination of all unnecessary factors in the present system of distribution.

(b) The organization of commodity sales agencies.

(c) The standardization of farm products into grades and classes.

(d) The warehousing of sufficient quantities of products to set up an even flow of such products into the market of the world as the immediate demands of the world call for them.

(e) The devising of such credit machinery as will enable the farmer to market his products in a sane and orderly way.

THE LAST THE MOST IMPORTANT CONSIDERATION.

In the study of any phase of agriculture at any point in its varied processes from cheaper and greater production to the installation of a real system of marketing, the student is always in the final analysis confronted with the problem of providing the necessary funds with which to do the necessary things sought to be done. You can't pay better salaries to preachers and teachers; you can't have better school houses and churches; you can't build warehouses and elevators; you can't provide improved machinery and improved livestock; nor can you install lights, and running water, or Ford automobiles, or carpets and pictures for the farm home; nor can you pay your debts and market your products over a period of twelve months instead of four, unless you have money with which to do it, and this presents, therefore, the all important problem of agriculture at this time. All others are insignificant in comparative importance.

THE APPLICATION OF AN OLD LAW WILL DO IT.

The existing banking system of this country has been built up to meet the especial need of commerce.

The turn over of the capital investment of the average merchant is once in sixty or ninety days and hence you have the sixty-day paper of the Federal Reserve Act. The banker, through long years of training, thinks in the psychology of a quickly maturing paper, not only this, but he would not be either safe or a successful banker if he did not think in such terms. Banking assets to be profitable must have a rapid and constant turn over.

The turn over of the capital investment of the farmer is once in 365 days, and for some unaccountable reason his debts have been made to fall due at about the same time each year and only once a year. A paper, therefore, with a maturity of only sixty or ninety days, certainly, in times of financial stress when money is hard to get, is of little value to him. If we are to solve this credit problem, we must provide him with a paper which has a maturity period equal to the turn over period of his investment, and a paper of less time than nine or twelve months maturity, better fifteen months, cannot be of the greatest value to him.

To my mind a system can be devised which will meet this necessity and it must rest for its success on an old law of economy which has been used

time out of mind by every great business concern to finance itself. This law is predicated upon the pooling of the assets of the concern and the issuance against such pooled assets certificates of indebtedness or debentures in varying denominations and periods of maturity. What is a railroad bond? It is the outstanding evidence, and promise to pay, of the fact that the railroad company has pooled its various assets—its engines, its work tools, its rolling stock, its right of way, into the hands of a trustee, and over which has been placed a blanket mortgage, and that all of these assets are good for the redemption of any of these obligations. What is a government bond? A government bond is the evidence of the fact that Congress under the Constitution has the power to tax all of the assets of all the people to make good the face of the bond. The most striking illustration, however, at what we are aiming at is to be found in the operation of the farm loan system.

A piece of farm land in itself, no matter how valuable, will fail to unlock the doors of credit. A farm mortgage on the same piece of land in itself would have no standing in the money markets of the world, but when under the farm loan act we have set up 4,000 associations of farmers throughout every agricultural county in the United States, and when these associations have taken in many farm mortgages—in the neighborhood of 126,000—and have placed these in Federal Land Banks—regional banks—in the hands of a government appointee known as a farm loan registrar, and these banks have issued against this mortgage farm loan bonds, the Missouri farm has become through this magic a liquid asset which flows freely in the money markets of the country. Under this system within three years of actual operation we have loaned approximately $440,000,000 at interest rates of from 5 to 5½ per cent, and upon the amortization theory of repayment of principal. What is a farm loan bond? It is evidence that a trustee has in his possession farm mortgages which if foreclosed would be sufficient in value to meet the obligations of the bond.

THREE THINGS THE HUMAN FAMILY MUST HAVE.

There are just three things, food, clothing, and fuel, that are necessary to sustain life and civilization, and two of these it will be noted are the products of the farm. It would seem to me that what the human family must have should be susceptible of being made the basis of credit. We can get along somehow without the engine on the B. & O., but we can't get along without biscuits. We cannot safely undertake to convert one of the B. & O.'s shovels into a shirt or one of its picks into a pair of breeches, but we have got to have Southern cotton and Western wool, and that can be made the basis of credit if we shall but apply to them the well known principle of pooling them and issuing against them debentures. The country should be provided first of all with adequate warehousing and elevator facilities. The warehouseable products of the farm should be warehoused and against them should be issued warehouse receipts by commodities, and these warehouse receipts should be pooled in the hands of a government trustee, regionally, and against these there should be certificates of indebtedness with varied maturing periods issued and offered for sale upon the money markets of the country, just as are the bonds of the government and industrial establishments. It may be necessary, in order to give these certificates prestige, to have back of them as an initial capital a revolving fund of sufficient size appropriated out of the treasury. But any scheme of this kind should look ultimately to providing its own capital and retiring the government capital so that the system would be purely a farmers' system, operated under government supervision and regulation, as is the farm loan system. Such certificates would undoubtedly command a ready sale at a reasonable rate of interest, and from the sale of such certificates the farmer would derive

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the money with which to do the things that are necessary to make country life worth while. Already in the states of Washington and Idaho a plan almost identical to the one here suggested is in actual successful operation, but it is my thought that for these certificates to sell at the lowest rate of interest it would be wiser to regionalize rather than localize the system.

THIS DEPENDS ON ORGANIZATION.

The working out of this system of farm credit, as well as the solution of all the other problems of agriculture, depends upon organization of the farmers themselves under sane, conservative, fundamentally sound leadership. Without this, all these efforts will fail. With it there can be but success.

FORESTRY IN RELATION TO LAND DRAINAGE.

By W. Darrow Clark, Chief Forest Fire Warden, Forestry Division, North Carolina Geological and Economic Survey

The forestry work of the State is under the Forestry Division of the North Carolina Geological and Economic Survey, of which, as most of you probably know, Colonel Joseph Hyde Pratt is director. In assigning to me my topic, Colonel Pratt also authorized me to treat it with as broad a latitude as I wished. I will therefore emphasize at the outset the direct relations between forestry and drainage, and then touch upon certain aspects of forestry which concern everybody.

The digging of trenches through wet lands for the purpose of lowering the water table has been practiced for ages by those interested in the production of agricultural and horticultural crops; but in North Carolina this practice has developed the fact that the lowering of the water table by trenching where it is too high is as beneficial to forest tree growth as it is to the growth of other crops. Owners of extensive cut over swamp lands have discovered that the increased rate of growth of pine and other forest tree species is sufficiently great after trenching to justify the cost entailed. Thus, even in the event that all our swamp land area may not be needed in the immediate future for agricultural development, still its drainage may be justified by its effect in stimulating tree growth as well as by its beneficial effects upon general health conditions.

Every man, woman, and child in America is vitally concerned in the perpetuation of our forests. It is obvious that a great many do not realize it and for this reason the problem of perpetuation is made increasingly difficult.

To bring the great mass of our people to a very clear and definite realization of their dependence on proper forestation falls as a duty upon those who can visualize what the situation in the country will be unless greater efforts are exerted to reforest the vast areas of nonagricultural and cut over land, and to stop the enormous annual destruction by fire of young forest growth as well as mature timber.

Many of our strongest advocates of forest conservation now realize that a great deal of the propaganda of the past which was designed to promote forest perpetuation has tended toward a crystalization of public sentiment antagonistic to one of our greatest national industries but has accomplished little or nothing towards actually increasing forest production. Such agitation has also signally failed to stop the forest fires which annually destroy millions of acres of promising young forest growth and mature timber at a rate which exceeds annual utilization for constructive purposes.

Lumbermen do not create the enormous demand for their wares. This demand originates in the God given impulse within mankind for progress and development. The lumberman has been the instrument through which the demand has been supplied. He has been the expert in the conversion of trees into lumber shapes for building the homes, factories, stores and warehouses which fill our land; for the construction of railroads and ships, bridges and docks to transport all necessary supplies and to distribute to their various markets the produce of farm and factory.

He has succeeded most in the lumber industry who has been able to supply best and at lowest cost what the consuming public has demanded. Keen competition and hazardous risks of large investments has threatened him with financial ruin and many there have been who failed. Mere self-preservation has been the restraining force keeping the woods operator from conducting selection cuttings, from leaving seed trees, from providing adequate protection against forest fires and from carrying on all other methods advocated for the public interest and for future generations.

Any claim that the lumbermen as a class are less interested in the general welfare and prosperity of this country than any other class is surely without foundation in fact. Not only that, but his mere selfish instinct, of which he probably has about as much as any normal man, certainly would tell him that the demand for his goods would bear a direct relation to general prosperity.

The amazing development of the American industry which we have feared at times to be outstripping our natural forest resources has developed quite independent of human control just as other industrial, economic or physical forces develop independent of human control and often in spite of attempted human control. The Sherman anti-trust law was verbally directed at combinations in restraint of trade. It has been used by a governmental department to threaten lumbermen against curtailing output in order to control prices. At the same time another governmental department is advocating conservative cutting, the leaving of seed trees and other reserves, close utilization of inferior materials, all of which necessitates scattered logging and increased costs all along the line. This could only have been done at a loss unless the lumberman could increase his selling price in proportion to the increased costs which the other governmental department threatened him not to do. Our broad gauged operators have been willing to carry out constructive policies looking toward forest renewal if they could only cover the costs involved. But they could not compete in a free-for-all market where shortsighted operators would sell at a price allowing only a narrow margin over costs of cheap, destructive and wasteful methods of logging and manufacture. In many instances increasing taxes on standing timber has forced hasty exploitation. An annual tax on growing timber is as unfair and unwise as a weekly tax on growing cotton, corn, tobacco, or any other annual crop. Timber is not an annual crop, but more nearly a century crop. All taxes on growing timber should be deferred until the timber is cut. In the meantime a nominal tax on the bare land value should be levied.

Our country is what it is because of the very liberal use which has been made of the wonderful natural resources with which it was endowed. But this in no way excuses or justifies wanton waste or disregard for future supplies of such resources as are renewable.

Without question our people are beginning to realize now that more should have been done to establish new forests when the old ones were utilized and most especially have we all been negligent for our inefficient action in the manner by which we either have attempted or not attempted to stop the rapacious slaughter of forest growth, both young and old, by fire. But both forest production and forest protection are too long an undertaking and too

broad and complicated by too many factors difficult of control for any one class of individuals, or any one class of industries, to handle it successfully.

The active and intelligent support of all the people is just as essential in this task as it is in the task of stamping out disease, crime, vice, extravagance, or any other form of immorality, and until we begin to work on that basis we are doomed to failure.

Before we can accomplish this great task which our continuous prosperity and welfare most surely demand, the new spirit of universal coöperation must wholly supplant the old spirit of antagonism, of passing the buck, of blaming this industry or that industry, or this class or that class.

This can and must be done!

It is hardly possible that any very large percentage of our people can be made to thoroughly understand all the whys and wherefores, all the complex details and all the tactics of accomplishment any more than that they should all thoroughly understand military tactics in order to wage a successful war. But the winning of their moral support is absolutely essential in both undertakings and for this reason an educational campaign must be conducted on a wide scale. The schools, the press, the lecture platform, the pulpit and moving picture houses can all do very effective work in such an educational campaign.

Our local conditions, climatic and physical, as well as human, are so very different that we should never undertake too much standardization. Local experts should have ample authority and means in the choice of methods by which local forest protection and local forest renewal is sought. Local forest laboratories and experiment stations must be established for ascertaining the facts in regard to growth, reproduction, and susceptibility to damage by fire of our different tree species as well as to demonstrate their applicability for various uses. The naval stores industry which formerly was of so great prominence and profits in this coastal country can be restored by the application of intensive methods. In a former publication of our office Colonel Pratt points out how France introduced a lucrative naval stores industry in a land of fever ridden swamps and barren sandhills. North Carolina will not have to introduce the naval stores industry; it is only necessary to direct and assist a natural restoration. Provide seed trees, fire protection, and protection against hogs, and the longleaf pine reëstablishes itself and makes rapid growth.

The lumbermen, I am convinced, can be and may be relied upon to be very instrumental in the development of an efficient plan and organization for handling this problem on a broad scale, and they will guide and direct in establishing safe and sane state and national forest policies. They have built their rail and tram roads, their flumes, sled roads, and pull boat systems into the wild and inaccessible places from our loftiest mountain tops to the lowest swamps. They have bridged canyons and hurled steel cables from spar to spar and made the huge logs yield to indomitable force. By the amazing application of powerful and wonderfully designed machinery they have gathered the raw products of the forests, converted them into usable shapes and distributed them to our local markets for the further fabrication by carpenters, builders, and all manufacturers of wooden articles. They have dredged and drained the inundated swamps and made them produce corn to the tune of 40 to 50 bushels per acre without the turning of a furrow or application of a bit of fertilizer. Their spirit of adventure, their courage, their hardihood, their hazardous risk of large capital, their able management and skill have never been exceeded in any line of endeavor by any race of men. The countries of the world have sent their agents to them for instruction in methods of harvesting forest crops. But as a prophet is not without honor save in his own country, so the American lumberman has been reviled

as the wicked lumberman, as the despoiler of virgin forests, and nature's beauty spots.

A little sober thought should convince us that our economic and industrial system for which we all bear our due share of responsibility, has been the cause of all the damage that has been done, and I have no desire to minimize or belittle that harm. Let the average American have the truth and we may rest assured that he is manlike enough and courageous and just enough to put the blame where the blame rightly belongs, and to grant honor where honor is due. The unnamed captains of our great American lumber industry have shoulders that are broad and backs that are strong. They will take up their full share of the burden of restoring the forests. They know the woods, they have the practical experience, they have the organizing ability, they have the vision and the will, but they simply cannot do it all. Give them but the necessary wholehearted confidential support and I feel convinced that they will accomplish in a most creditable manner both adequate fire control and adequate reforestation.

The carrying out of a program adequate to meet the needs of the situation will call for the expenditure of sums in proportion to the magnitude of the task. As the matter of size of cost becomes of less moment, the manner of distribution of cost becomes one of greatest importance.

From each according to his ability, should be the personal impulse and equity as between landowner, manufacturer, consumer and general public; should be the public principle through and by which the cost should be distributed.

State and national appropriations for providing adequate forest fire protection, for providing scientific investigations in regard to the growth and habits of our different species, for providing forestry experts to advise private owners, are suggestive ways by which the cost of reforestation may be publicly distributed. The method involves no new governmental policy. The same methods have been employed successfully for years in connection with all lines of agriculture, animal industry, fruit growing, foreign trade, and in many other lines.

Mistakes will undoubtedly be made and failures experienced here and there, but to the extent that we are an intelligent and progressive people we will in the main succeed. We will repair any damage that has been done and then proceed to make two or more trees grow where only one or none has grown before.

OBSERVATIONS ON SOME FEATURES OF DRAINAGE AND LAND DEVELOPMENT.

BY C. G. ELLIOTT, Consulting Engineer Elliott and Harmon Engineering Company

Mr. President and Members of the North Carolina Drainage Association:

When solicited by the President of this Association to fill a number on the program, I thought of the considerable number of papers, monographs, and essays which I have prepared on the subject of drainage during the forty-four years of my practice in drainage engineering. Many of them are packed away in secluded corners, and I devoutly hoped that some one of them would be timely and appropriate for this the Eleventh Annual Convention of this Association. An examination, however, showed as it has on former occasions when I desired to shirk the labor and responsibility of presenting something up-to-date on this important subject, that the development of practice and methods of agricultural drainage in the United States have been so progressive and continuous that what was new last year is old today. For this reason I have never been able to so modify or revise an old paper on the

subject that it would fit into the program of some subsequent public meeting in such a way as to be appropriate and helpful. Not that the general principles and theory of drainage have changed, but the successful adaptation of the principles to the conditions of land and climate we meet, the improvement in design and the progress which is yearly made in the construction of works bring before us changing phases of reclamation problems which require the exercise of new thought and its expression by new literature. Really, until we take the time to review drainage methods somewhat in detail we fail to appreciate the advances we have made. Our ideas and methods of drainage were borrowed from England and Scotland. Colonel George E. Waring adopted English methods in draining the grounds of Central Park, New York, and perpetuated them in his book, "Drainage for Profit and Drainage for Health," published in 1867. A prominent landowner in Kentucky whom I visited in 1901 deprecated the fact that the perusal of Waring's book delayed him for ten years in the drainage of his farm, which at that time he had accomplished to his satisfaction. His land did not have the slope that Waring said was required for the efficient operation of drains, and furthermore, the expense carrying out such design as he found advocated in Waring's treatise would be prohibitive.

The prairies of Illinois and Indiana were thought to be too nearly level to be drained. I recall that in 1877, or thereabouts, the Chicago & Alton Railroad Company circulated a leaflet which had been prepared by Mr. H. W. H. Cleveland, an architect and engineer, setting forth the fact that tile drains would operate successfully when laid on a gradient as small as two inches in one hundred feet. I remember with what trepidation I first surveyed a drain to be constructed on that grade, three inches per 100 feet being then considered the minimum.

In this connection it should be observed that the railroads were ardent advocates of and helpful agents in the pioneer work of draining the lands of Illinois, Iowa, and Indiana. They sent representatives to the conventions, made low transportation rates on drain tile and ditching machinery, and were liberal in treating assessments which were made against their properties for carrying out public and private drainage improvements.

With these few words of introduction, I ask your permission to defer to others the presentation of technical and constructive phases of the subject, and at this time to call attention to some related topics which I have in mind.

Drainage in this State has been advanced largely through educational methods comprising public meetings devoted to the discussion of local drainage, the enactment of a State drainage law with its several amendments and through the persistent activities of this Association, I should not fail to add to these agencies the examples of satisfactory drainage which are more forceful and instructive than all others. I hold that landowners should be informed on the principles and value of all basic land improvements like drainage, but that they should call to their aid the drainage engineer when they contemplate carrying out any extended work. This suggests the training that such engineers should have and what their clients, the landowners, should expect of them. We have had the matter up with our friends at the State University. They are of the opinion that if they teach in a regular way the mathematics, the surveying, and the principles of hydraulics involved in the practice of drainage engineering they have taught the science and art of the profession as far as they are called upon to do. They then turn the student out with the advice to learn the practical part of the profession as best he can. Where will he learn and who will perfect his education in drainage? He goes out into practice and acquires the details of his profession with a varying degree of proficiency at the expense of his clients.

We have three classes in the profession: First, the well schooled technical man, who is taught to believe that mathematics should be applied to every detail, and that water should flow according to accepted formulas as taught in the books. He may or may not be able to correlate the factors and adjust his design to local hydraulic conditions. Second, the man with considerable practical knowledge gained through observation and experience with a smattering of hydraulics and a good knowledge of leveling. While assuming to be technical in his profession, he in fact does his work by rule of thumb based upon his judgment and observation. Under conditions with which he is acquainted he does it satisfactorily. Third, the well trained drainage engineer, who combines the qualities before enumerated with the added knowledge of soils and agricultural economies and experience and the practical application of hydraulics to problems of drainage. We engineers frequently place too little weight on the skill that comes from critical observation and application of facts. Technical knowledge is not always applied correctly. In my examination of plans I have frequently found radical hydraulic errors in the design of drainage works. Does not it come within the province of the school to start the young engineer right in practice as well as in technique? Give him field practice as is done with the railroad, the topographic, the geologic and the mining engineer.

There is another point I want to mention. I take the privilege of talking freely because I do not feel dependent on any political constituency or departmental machine for my subsistence or reputation. A drainage engineer should be informed upon agricultural soils and how drainage will affect their productiveness, the common economies connected with the development of reclaimed land, in short, be able to advise his clients upon all phases of drainage plans and whether or not the development will be profitable. Some lands are not worth draining for agriculture. Who should advise upon this point if not the engineer. I am not holding that he should be an expert in all of these departments; but he should know how to secure the information and be sufficiently trained to digest it himself and lay it before his clients in a clear manner.

I am aware that this view is not approved in certain high places. I have had something to do with drainage matters in the U. S. Department of Agriculture, and have been instructed that drainage engineering is devising means to get water off the land. The work ends there. If we want to know if soil has merit we should turn it over to the Bureau of Soils. Through official channels and in due time we may get a report with a mechanical analysis and an account of what is growing there and how far the land is from market and various other descriptive matter. But if it is swampy and uncultivated, we will be left in ignorance as to its possibilities, with the suggestion, perhaps, that if the land were drained soybeans or some other staple might be planted. If they grow they may make a crop. The information we most need is wanting. Do the owners want to know if the land can be developed into small farms and homes for rural population they are advised to turn it over to the promoter, the land dealer, or the immigration agent without note, comment, or advice, with the assurance that in due time that fact will become known; but if the drainage engineer assumes to investigate and advise upon those important matters he is reminded that his business is limited to outlining methods of getting water off the land.

I do not concur in these views nor in such methods. I believe that those engaged in this work should learn the physical nature of the soil and subsoil, anticipate what use it can be put to, whether the location and environment are such that the land can be profitably developed, and develop plans for draining in accordance with the facts; that the problem in its entirety should be rounded up by the drainage engineer, so that his clients may be advised of all

the facts and of their relation to each other. There is no professional work which is more varied in its details, or more subject to the modification of set rules than land drainage. We need facts and the ability to interpret and apply them correctly.

A late Secretary of the U. S. Department of Agriculture asserted with great assurance that all tile drains should be placed four feet deep because tile at such depth had under his observation proved efficient in certain localities, and also that drain tile should be soft and porous so that water might filter through the walls. The need or value of this quality was disproved years ago, and is but another instance of the progress made in practical drainage since its early days and of the failure of a man of science to keep in touch with the facts. Perhaps I should not whisper it but there are agricultural instructors and professors who now teach that drain tile should be porous so that water may percolate freely through their walls, and thus render effective drainage to the soil. It is in the old books, and some of them have not studied the later ones. I regret to confess in this connection that one of the leading civil engineers' pocket books, or more properly, hand books, in giving directions for drainage have this to say: "The tile now on the market are so porous as to offer ample opportunity for water to enter the drains through their walls."

Engineers should temper their technical knowledge with a liberal amount of practical hard-headed common sense derived from close observation. I have known trained engineers to make errors in drainage design that the ordinary workman who has acquired his knowledge by experience would not be guilty of. About forty years ago, when drainage was frequently discussed, but none of us knew anything about it, a prominent professor of civil engineering evolved and published a formula for use in determining the volume of flow and the required size of drains, with the comment that we might expect nothing more complete. It was the last word that might be expected, because it was in strict accordance with mathematical principles and hydraulic laws. I am reminded of an anecdote of Thomas Telford, the eminent road engineer, and one of the early presidents of the Institution of Civil Engineers of England. It is related of him that when on one occasion he was consulted by a young man as to the advisability of his engaging in civil engineering as a profession, he said to him, "I have made all the canals and all the roads and all the harbors. I don't see what there is that you can expect to do." While the works which had been accomplished by Telford up to that time were numerous and important, yet the great area of the Fens was then being opened up, and engineers of note were called from Holland as well as from his own country to assist in that great reclamation.

May not what I have said illustrate a failing that some of us have in handling important and expensive undertakings in drainage? We fail to get all the facts that have a bearing on the proposition. Landowners and drainage district officials begrudge the time and expense required in securing adequate preliminary data.

I have discussed matters relating to my own profession more than I intended to do. We have a placard on the walls of our office which reads, "He who makes no mistakes, does nothing; he who makes many, loses his job." Mistakes are the engineers nightmare. The tendency in some quarters is to ignore facts which will not favor our purposes. The land promoter ignores difficulties. The engineer must face and overcome difficulties, and to do so must have all the facts and give to each its proper weight. Even then he sometimes makes enough mistakes to greatly disturb his peace of mind in later years.

There is another phase of this subject which it seems to me may with propriety be referred to at this time. It has come to the attention of Congress and of those who are identified with the Government service that there is a

great waste through duplication of work and misdirected effort in the administration of the several departments of the Government, and it is proposed to reorganize said departments with a view of establishing a regime which will increase efficiency and economy throughout. It is quite clearly evident and has been apparent for several years that such a reform is needed. However, under the existing order of affairs in the U. S. Department of Agriculture, there are wastes which are not the fault of organization but of administration of the several bureaus. There are experiment stations in every state in the Union which are supported by Federal appropriations frequently supplemented by liberal additions by the states. An immence volume of experimental work and investigations are carried on by the several bureaus and Federal stations. The shelves of their quarters are loaded with data, notes, measurements, and illustrations, which have been turned in according to instructions, and are apparently pigeon-holed for all time. No attempt is made to sift out the facts, digest them, and make them useful to the locality from which they are obtained. They are dead goods and the labor employed in securing the facts has served no useful end to the people. If a bulletin is issued on some subject, not infrequently it is divested of live and pertinent facts, and the generalizations on the subject are substituted, which fill up but do not enlighten the reader. To illustrate, there is a rule that no facts resulting from investigations relating to subjects peculiar to the needs of North Carolina can be made public until the same are available to the people of California, and all other parts of the country. To do so might give some section advance information, and hence an advantage over another. Directions are further given that no bulletin should be issued until the subject therein treated contains all that can be said or ever will be said on that subject. It must be a complete compendium. It must be the work of experts who have learned it all. Hence it is that there is a store of valuable facts in the Drainage and Road Office, and in every other bureau of the Agricultural Department, including the state stations, which is salted down and useless. It is not necessary to express a conclusion if the facts do not warrant it nor evolve a complete treatise on a subject whenever an investigation is made. Facts are the bases of practical operations. Agricultural investigations are always local in character. The people of one locality are not particularly interested in the difficulties which those of other localities are obliged to meet. Why wait until in the course of governmental events a well prepared dissertation has been prepared and issued at large cost and distributed to the people at large when the matter therein contained is of use to not more than one per cent of the people. Some of the vital and controlling facts given in the locality which was covered by the examinations, if timely, might have been useful. There are just as competent men outside the bureau as inside, and their coöperation would strengthen the investigation. So I would say give us the facts with their local environments in an intelligent form and let them be continuous and timely. Strange to relate, there is a dislike on the part of those engaged in public work to acknowledge that they do not know all there is to be known on the particular subject. I have been interested at the efforts of some of our scientific observers in the invention of an excuse for withholding a conclusion derived from the data he had. In one instance I could name, the investigator attempted to account for a flood, and after a lengthy discussion of the facts that were available, including rainfall records covering a period of forty years, he confessed that the rainfall record was so meager that additional data along that line would be required. The inference is that we must wait another forty years if we are to have his assistance. In the meantime we would use the facts if we could get them and work out the problem as best we may until better data are secured.

There are several large reclamation projects under way in Eastern North Carolina, and other meritorious ones remain to be worked out. Those interested in them are concerned in securing farmers who will occupy the land as soon as it is drained and who will bring it into production. It goes without saying that unless land is put into productive use, its drainage will be a financial loss. The settlement of newly-opened-up lands by good farmers is the most important problem now connected with the permanent development of the lands in Eastern North Carolina. When a part of a farm which is already occupied, equipped, and operated is drained, there need be no delay in fitting newly-drained parts for some useful purpose. But not so with large and more or less inaccessible areas of cut-over swamp lands. The making of farms in such locations means pioneer work, work entirely different from that done by farmers on well improved lands which are contiguous to the conveniences and many luxuries of modern life in the agricultural districts. The new lands must be ditched and some part of them made to produce a crop as quickly as possible. A few necessary though not elaborate buildings must be put up, some livestock brought in, and roads built. Assuming that the public ditches have been made and the land subdivided into tracts of suitable size for farms, the question arises as to how it may best be successfully and permanently settled? In the case of ten thousand acres or more it means a new community with its attendant social and political organizations. We should not forget that settlements will be made up of people of average attainments, not of men possessing initiative and unusual ability in conducting their business. The quotation is frequently used, "What one man has done another can do." This is not true in a practical sense in land development. We must deal with average farm conditions and with such men as will be attracted to these lands.

We have the colonization method, which consists of gathering a company of families who have certain national, religious, or social bonds that unite them and make their associations attractive. While this plan has been satisfactory in some instances, it has failed in others. Lack of thrift on the part of some members, or unforeseen adverse conditions of a general character which affected all have sometimes discouraged the settlers, who abandoned their holdings.

There is the time honored method of individual settlers who, upon receiving reliable information regarding the locality, seek the place knowing what they want and what they can do. They settle down to the work with a partial appreciation at least of the task that is before them with a knowledge of their business and faith in the benefits they will finally secure if they persevere. Happy is the district where such people cast their lot. If large tracts which have been reclaimed at a considerable cost under drainage organizations are secured by speculators, that is, by those who do not intend personally to utilize them, but sell to the actual farmer as occasion may offer, the reclamation is delayed and the price of the lands to those who later must fight the battles incident to the making of farms from the raw land is increased.

In this connection I feel like registering a protest against certain teachings of the agricultural press and of lecturers on modern farm life. They tell us that people cannot be expected to go on the land and be farmers in these days unless they can be supplied with city conveniences, such as hard roads, lights and waterworks, sewers, etc. They condole the lot of those who are compelled to do without them, and censure those who fail to keep their home establishment equipped with modern improvements. They compare the home and surroundings of the well to do farmer with those of the pioneer on new land to the disparagement of the latter. It should be remembered that farm life has an atmosphere which is wholesome and peculiar to itself; that town amuse-

ments and bright lights are not necessary nor even conducive to the development of character or happiness of the occupants of the farm. They teach that more than eight hours labor in a day works great hardship and an injustice on the farmer be he owner or laborer. They decry the farm tenant system as pernicious to progressive agriculture. Some of our self-constituted teachers in rural affairs are too academic. They know little of practical affairs relating to land and agriculture. They regard the flash and frivolities incident to town life as a necessary adjunct of farm life. If these teachings prevail, and they are being widely disseminated, we may look in vain for the settlement of our new lands which require initiative, hard and persistent labor and more or less privation in the beginning. We will see a congestion of people in and near the towns and cities while the broad acres of the Carolinas will remain unoccupied and unused.

This State has lands which should be attractive to those who can appreciate their value and at the same time can understand the difficulties of thoroughly reclaiming them. I venture the opinion that the high selling prices of the older farming lands, and the inability of many to maintain the luxuries of the higher farm civilization in our older sections in which national and local high taxes will be an important factor will result in some radical changes in ownership and management. The land will produce no more, but the cost of operating will be greater. Luxuriant farm homes, very desirable in themselves, and high class schools, roads and other desirable requisites will entail more expense than some will care to carry. They will then turn to the new and cheaper lands such as the Carolinas offer and find prosperity and contentment in them though their immediate surroundings may lack some of the modern improvements of the age.

TILE DRAINAGE

BY H. M. LYNDE, Senior Drainage Engineer

The United States needs more drainage. North Carolina needs more drainage. Eastern North Carolina is particularly in need of more drainage, and by more drainage is not necessarily meant more land reclaimed. There are hundreds of thousands of acres now under cultivation in the State which need better farm drainage to produce maximum yields. While this is probably not the time to speak about increasing our production, in view of the low prices now prevailing for southern products, yet we must realize this condition is only temporary and that all the easily developed portions of the country are being utilized. There has been and will be again a time when we must increase our production to take care of the increasing population. Everybody here must admit that this is the primary purpose of the North Carolina Drainage Association.

We must increase our production in two ways: first, by reclaiming the swamps; second, by intensifying production on land now under cultivation; and one of the means of doing this is by better internal drainage of the soil, which is a subject not related merely to the removal of surface water. The basis of good soil management is a correct water supply, not too little or too much, but the right amount at the right time.

The ideal system of drainage is one which is adequate, not a hindrance to cultivation, and uses the least possible land. Such a system is most nearly secured by the use of tile drains. Although there is urgent need for tile

drainage in all the Coastal States from New York to Florida, comparatively little along this line has been done. This being the case, it would seem that this is the year of all years to make permanent improvements—this year while labor cannot be profitably employed making "money crops." As the *Progressive Farmer* stated in a recent issue, "If a farmer wishes to clear, ditch, tile or terrace land, this is the year to do it."

Let us look at this question of tile drainage honestly and fairly. Tile drainage is being practiced on a very limited scale in North Carolina; and why? Probably the principal reason why tile drainage is not more generally practiced in this State is because the great results to be obtained from under-drainage are not generally understood. Another reason given by the man who appreciates the value of under-drainage is that he has not the ready capital with which to do the work. One man says that tile drainage is too costly, that the land is too low in price to pay for such a seemingly expensive improvement. Another says that it will stop up anyway if you do put it down. Some think that they are getting good enough drainage by the present methods. The problem in this State, in my judgment, consists largely in inducing the farmer to change from an old method to a new method of drainage to convince him that tile will drain better than open ditches.

In the Middle West, in the beginning, those farmers who installed tile drainage systems were considered highly adventurous and foolish. These early systems, however, have been the cause of an ever-spreading realization of the need of under-drainage and of its benefits. Iowa alone, in 1916, according to a report on "Clay Working Industries," published by the U. S. Interior Department, produced $4,000,000 worth of drain tile, while North Carolina produced only $18,000 worth, hardly enough for ten fair sized farms.

Tile drainage will increase crop yields for the following reasons:

1. It lengthens the growing season.
2. It increases the benefits of fertilizers.
3. It gives better soil ventilation.
4. It prevents crops from drowning out.
5. It safeguards crops during drought.

Another thing that tile drainage does is to increase the area of the farm and simplify farming operations by doing away with the open ditch. Many farms, no doubt, in this section have nearly five acres out of every hundred occupied by ditch and bank. I honestly believe that tile drainage will pay for itself in about six years from the crops raised on the narrow strips redeemed from open ditches.

After all the usefulness and helpfulness of tile drainage is not measured by what we *promise*, but by what it performs. No one is so well qualified to speak of the value of tile drainage as those who have tried it. We have with us today some men who have tried it, and I am going to call on Mr. Cline, Mr. McCotter, Mr. Shook, and Mr. Latham.

TILE DRAINAGE IN OUR BLACK LANDS

By A. S. Cline, Assistant Director Branch Experiment Station

The question has sometimes been asked as to whether tile drainage is practicable in the black muck soils of our reclaimed swamp districts. Two possible objections to it have been raised: one, that because of the extremely flat grades

necessary in laying the tile, this tile would tend to fill up with muck seeping through; and the other, that as the black soil settles the tile lines would sag out of grade and spoil the drainage.

However, the experience we have had with the use of tile on the Black Land Station of the North Carolina Department of Agriculture, located at Wenona, N. C., is a sufficient answer to the objections. Its operation has been an unqualified success. Three and seven-tenths miles are now in use on this farm. This tile is laid at a minimum depth of four feet. On this farm the depth to clay is 3½ feet, so the depth used allows the tile to be firmly laid in a clay bed which precludes the possibility of it ever settling out of grade. The grade used varies from ½ inch to 1 inch per 100 feet. The lines are spaced 330 feet apart, this being the standard spacing for all open ditches in this community. On the first part of the farm drained only a main, with no laterals, was used. With the latter drainage a main with laterals at right angles, spaced the same distance apart as the mains, is being used. Size of tile used varies from 4 inches up to 15 inches; but we have arrived at the conclusion that 5 inches is the smallest diameter advisable to use in muck soils. All outlets are in the main drainage canal.

The first line, consisting of 4 and 5-inch tile, was laid in the spring of 1915. After six years use, it is working perfectly and no objections to it have been found. The second line, of 4 and 5-inch tile, was laid in the fall of 1915. In the third main, laid in 1916, 5 and 8-inch tile were used. The fourth line, laid in the summer of 1919, was 10, 8, and 5-inch tile, while the laterals emptying to it are of 5 and 4-inch. The fifth and last main laid in the fall of 1920 will drain 110 acres; 15, 12, and 10-inch tile were used in this. The grade of this main is ½ inch per 100 feet. With this almost flat grade, the tile is working perfectly.

The cost of tiling varies somewhat with the size of tile used. For the work done in 1920 an accurate record was kept, and the cost, exclusive of tile, was 15.4 cents per running foot for the laterals and 20 cents for the main. Labor was based at 36 cents per hour. This soil is full of wood, especially cypress stumps, which increases the cost of cutting ditches materially. Prices of tile can be secured from factories. The 15 and 12-inch tile purchased last year cost 71 and 48 cents, respectively, per foot. This was No. 2 sewer pipe, as farm tile of the diameter mentioned cannot be secured in this State. For the work done last year the per acreage cost was $18.57, exclusive of cost of tile. With the prices paid for tile in this case the total acreage cost is $36.03.

In preparing an article recently for the *Southern Ruralist* on Tiling vs. Open Ditches, I found a yearly saving through no recleaning of ditches, no loss of land from cultivation, and no cleaning of ditch banks. Other benefits, as more thorough drainage, larger fields, rendering cultivation easier, no wintering place for noxious weeds and injurious insects, and no breeding places for mosquitoes, cannot be easily expressed in values of dollars and cents. However, using only the values I mentioned it will be seen that tiling will pay for itself within 14 years of use. When we know that many tile lines have given, and are giving, good service for 40 years or more, we have the answer as to whether tile drainage will pay in our black swamp lands.

No trouble from muck seeping through has been encountered on the station farm. An examination of the tile after a year's use showed it to be perfectly clean, there being no sediment in it whatever. As a matter of fact, this muck soil does not tend to seep through as does sand and silt. With many things to be said in its favor, and any possible objections yet to be discovered, I unhesitatingly say that tile drainage for our muck soils is a most profitable investment.

SUCCESSFUL USE OF TILE DRAINAGE

BY D. C. MCCOTTER

I have recently completed laying tile on one of my farms on which I have previously used open ditches, and I am much pleased with the results accomplished in tile drainage. It has more than doubled the value of my farm. Since laying the tile I have had good opportunity to test it out by reason of several very heavy rains which caused the overflowing of farms adjoining mine which had open ditches and the water stood on the farms with open ditches while my tiled farm was free from water. I also find that I can begin plowing twenty-four hours earlier on my tiled farm than I can on the farms with open ditches, notwithstanding the open ditches are in perfect order.

Furthermore, in the hundred acres which I have tiled I have a great many more acres in cultivation now which formerly were in ditch banks, and ditch banks are certainly expensive to keep in order, and yield no profit whatever.

I have been very careful to see that my tiled farm was properly put in and have spared no expense in seeing that it was done properly. I used plenty of straw over my tile after it was laid in the drain, and also used a cheap grade of roofing, placing small strips of same over each joint, and I certainly recommend the use of this, as my mains have been running clear almost ever since the day they were put in, which shows they are free from any obstruction.

I tiled this farm at a time when both labor and materials were very high, therefore the expense was greater, costing about $50 per acre; but I certainly do not regret this expense, as I value this farm at least $150 per acre more now than before being tiled. I cannot recommend too strongly the great advantage in the use of tile drainage, but would advise the use of clay tile.

EXPERIENCE WITH TILE DRAINAGE IN THE COASTAL PLAIN

BY L. W. SHOOK, Manager Cotton Valley Farm, Tarboro, N. C.

In 1916 and 1917 we laid many thousands of feet of tile on Cotton Valley Farm, replacing some six miles or a little more with about ten miles of tile. All of our land is very level, and in some cases we found difficulty in getting enough fall and also in obtaining suitable outlets. The land that we tiled was of two general soil types—the Norfolk and the Portsmouth. Some of the Norfolk soils were very variable in character and hard to drain on account of this variability. This was particularly true in one 30-acre field where pockets of coarse sand and sandy loam were thickly interspersed with pockets of stiff gray clay that was almost impervious to water. Often there were as many as a half dozen different kinds of soil in a linear distance of 100 yards. In wet weather these clay spots were regular loblollys, and in dry weather as hard as a brick. These areas are still rather wet, stiff, and hard to cultivate, but they are a great deal better drained than they were with open ditches. It is our purpose to lime this field this year and plant it to soybeans in order to improve its mechanical condition. Before tiling this field had been abandoned for several years, but it has grown a fair crop every year since it was tiled. We believe that with the addition of lime and humus we can have it producing good crops in another two years.

The most striking results from tiling that we have obtained were from a big Portsmouth bottom in the middle of a fifty-acre field. This bottom had no natural outlet; and, though very fertile, was very wet and hard to cultivate, and it was very rarely that good crops were obtained on it. Immediately after tiling, it became the driest part of the field and has produced excellent crops every year since.

Our results in other fields have been between the two instances cited above.

The advantages we have obtained from tiling are as follows:

1. Some areas have been made safe for full crop production that before tiling were almost sure to fail.

2. Some areas have been made to produce fair crops that before tiling had been abandoned.

3. By filling up the open ditches about ten or twelve acres have been added to the tillable area of the farm.

4. It is cheaper, easier and much more satisfactory to cultivate the fields since the open ditches have been eliminated. This saves much time in turning around at the end of the row and in going around the heads of ditches or to bridges to get to another part of the field. Twenty odd farm bridges have been done away with. The maintenance of these bridges alone was no inconsiderable item in the old days before we tiled.

The biggest mistakes we made were:

1. In not filling up the open ditches before tiling. We think this would have been a great help in our case, though it might not make so much difference under other conditions.

2. In not giving the tile fall enough in one or two cases.

3. In getting the tile too near the surface in one instance.

On the whole, we think it has paid us to tile the farm, though the results have not been what we expected in some cases. However, if we had it to do over we would not hesitate to do it, and we are sure we could do a better job the next time than before.

RESULTS OF TILE DRAINAGE IN EASTERN NORTH CAROLINA

By F. P. Latham

Mr. President and Gentlemen:

In the outset of this discussion it is my desire to make it entirely informal, and I extend to all the privilege of a question, and an open analysis of facts, as I feel that much more can be gained in this manner than by a set and prepared statement. I may not be able to answer some question; however, this will not in the least embarrass me, as I know of no one who has a license to possession of all the facts pertaining to the problems of tile drainage.

I desire to state that my knowledge of tile drainage is the direct result of practical observation of a system begun fifty years ago on the same farm upon which I was born, and still reside.

The surface of this farm is much like a great majority of the farms of Eastern North Carolina, level, and consisting of a sandy, clay-loam soil; that tile will do an efficient service, and a continued one, has been fully demonstrated by all these years of satisfaction; in fact those tile that were laid before my day, are if possible, doing better service than a new system, inasmuch as a water-free soil invites the roots of plants and burrowing insects to construct millions of minute channels, a condition impossible in a water-soaked soil, through these the water seeks the point of its level.

Observing the beneficial results of this system laid by my father induced me to undertake further work on some lands not previously drained, on this last work the land was almost totally devoid of fall, hence the grade had to be made without the benefit of natural advantages, some of these leads were longer than I care to put in (2,600 feet) ; however, by the use of a farm level, and doing the final grade and laying the tile with my own hands, I now have the satisfaction of enjoying the benefits of efficient drainage, enabling me to produce creditable crops where before profitable farming was impossible.

To the question of cost per acre, of course this item depends greatly upon cost of labor, tile, etc.; however, with $20 per thousand for tile as a basis, the cost in a reasonably porous soil should not exceed $12.50 per acre for general crop production. However, this must remain for the individual to work out on his own farm to fit his specific requirements.

We must always bear in mind that there is a clear line of demarcation between intensive and extensive agriculture, and what might be absolutely necessary for the profitable production of the intensive culture crops of truck and vegetables, might bring the cost a bit high for the general staple crops of corn, cotton, beans, etc., which can stand a little more punishment from temporary excess moisture, having more time for complete recovery.

Where this is likely to occur some provision to take care of the occasional downpour by surface drainage is often advantageous.

With tile properly placed in a soil through which water readily descends, and with an open outlet, where the silty water from surface drains do not back up the lead with pressure before the water from the surface reaches the tile, and where a true grade of not less than two inches to the hundred feet has been maintained, satisfactory drainage should result for ages with little thought of attention and maintenance.

I know of no other investment on the farm so permanent that is a revenue producer all the days of the year that compares with the satisfaction derived in cultivating all over your ditches without worry that will yield a better interest on investment than a well planned tile system.

In closing I wish to say that unless the individual has had actual experience it would be risky and entirely unwise to undertake the planning and putting in of a system without the aid of an engineer or some practical man who has had actual and successful experience in such work.

DRAINAGE VS. MOSQUITOES AND MALARIA

By Dr. T. H. D. Griffitts, U. S. Public Health Service

It is not recorded historically that the crew and passengers of the Ark were pestered by mosquitoes.

In round numbers, however, there must have been an infestation by at least 1,000 of these disreputable creatures. For of the 500 species of mosquitoes the old ship must have harbored a male and a female of each kind. This would have allowed a minimum of 1,000.

It seems certain, then, that the good old Mariner Noah, in executing the command to take a male and a female of each living creature aboard, rounded up this thousand. Or, perchance, there was a violation of the "sanitary code" in permitting the presence of discarded tin cans holding water, fire barrels, or like receptacles, where these damnable, pesky, and disease-purveying insects bred and infested the boat before sailing.

Let's throw the mantle of Christian charity about the entomological knowledge of those deluvial days and assume that Noah did not set the stage inten-

tionally for all the bad acting the multitudinous hordes of this perditious family have inflicted upon the species of the *genus homo* down through the ages.

No man can portray a hatred for mosquitoes more than one whose hatred is vehemently venting from a spleen argued from their malarious bites.

But have you ever contemplated the good even in a mosquito?

Only half of them bite—the females. The males do not. That's good, and the only good I know of.

And again, only a small proportion of the females of the hundreds of species are even capable of carrying disease about in their system. To most people a mosquito is simply a mosquito. But she has been a ruling influence in the destinies of empires, the collapse of military expeditions, the failure of national enterprises, the undevelopment of agriculture, the mortality rate, the throttling of prosperity and the disturbance of rest. She is the subject of conversation in any society; she will make your acquaintance readily and alike on the Ganges and the Yukon. She pumps the blood from the Eskimo while her distant relative imbibes a sanguinary luncheon from the Ecuadorian in siesta. She requires blood to stimulate egg-laying for the propagation of the species. And blood she gets.

With this foreword that suggests a mosquito is more than simply a mosquito, let us consider her in her relations to man and his well-being. For just practical reasons, these insects are divided into two general classes—disease carrying and nondisease carrying, or, for the present in the United States, into Anopheles and Culex.

The Culex pesters, the Anopheles carries malaria ("chills and fever") from the person infected with malaria to the well person, through her contaminating bite.

True, there is another variety still existing in this country that was in times past an object of grave concern, the little zebra-legged yellow fever carrier. She is here yet, but since there is no yellow fever for her to "tote," we pass her up and think of her damage only in retrospective moods.

But the malaria mosquito continues to purvey malaria in the South, and inserts her proboscis into the very purse to the tune of millions of dollars annually in economic loss.

For more than two decades the Anopheles mosquito has stood convicted of the crime of malaria, but her execution has been deferred. However, her liberties have been restricted, and both the area and degree of prevalence of malaria are today decidedly reduced under that of twenty or ten years ago. In some sections of the country it has entirely disappeared. In practically all portions there is a steady, permanent decline.

More and better farm drainage is being installed, connecting up agricultural with health drainage; homes are being screened to keep out the malarial mosquito along with her ally, the nasty, disease-carrying house fly. Prosperity and enlightenment have brought about a more general use of quinine and more permanent cure of malaria-infected cases.

According to historians, malaria in this country dates back to the Jamestown colony. It is believed malaria was one of the hands of death that laid hold of the colony when in the first eight months of their struggles sixty-seven of the original settlers died.

Cold weather checked the frightful illness and mortality. This disease, along with yellow fever, it is thought, was brought to the shores of America by ships that touched at the Antilles, members of the company getting infection there.

There are 189 separate and distinct ways by which we take sick and die, according to an international classification of the causes of sickness and death. In other words, let us say that it is a great drainage system by which

humanity is drained into eternity. As health engineers, we should plan and construct and maintain this system according to good engineering knowledge. Let us establish "old age" as the outlet channel and not allow it to become obstructed. Imagine the expense of a drainage system where every farm ditch must drain separately to the ocean. Then contemplate the waste of humanity where the old-age channel or outlet is obstructed and we get deaths by typhoid, malaria, tuberculosis, smallpox, pneumonia, and the appalling infant mortality—preventable diseases—that must be connected up with the natural drainage system. We must get away from this expensive system. And you in the Old North State are doing it.

Malaria is an absolutely preventable disease. It is one of the greatest single factors operating to retard development and progress in the South. It is wonderful development to do agricultural drainage, to lower the water table in this great section of "geological cream." We must go one better, and at the same time construct and maintain the drainage so as to keep down mosquito production with its consequent malaria. Use of tile drainage on farms is loudly called for in permanent malaria eradication.

Here let me say that Anopheles (malaria-carrying mosquitoes) like fairly clear, clean water, even fairly deep water, and the ditches and canals with quiet water, with cat-tails, bullrush, and the like, present ideal conditions for mother Anopheles to lay her eggs and raise her hordes of disease purveyors. Much malaria in the coastal section is "man caused"; wide-bottom canals and ditches that merely serve to hold water, and, probably, lower the water table; that serve as sumps or are a series of pools at low water stage, are a menace to health. Unemptying roadside ditches, undrained borrow-pits and high culverts that impound water may be found even along some of our new "good roads." I say that *no road is a good road that contributes to ill health along its course*, to the production of malaria-carrying mosquitoes.

It's a sad commentary that more than two decades after the simple cause of malaria transmission was known you can go into communities in this year of our Lord and find amongst otherwise intelligent people a deplorable prevalence of malaria; men in the field, in the shops, in the stores, on the streets, children in the schools, trying to work, trying to study—sick and don't know it, from a disease that prevails only through ignorance and inertia. I know of such a place where one church subscribed $30,000 to foreign missions and refused to spend $4,500 to get rid of malaria that was thwarting progress, shackling the mentality of its future citizens. One feels like saying, let the grown-up "old stiffs" suffer if they like, but how about those for whom they are responsible? Now, I believe in church work; I like the idea of foreign missions—it's a glorious work. But I do say that if we neglect such conditions as I have mentioned right in the shadow of our churches, in our own American communities, and call it Christianity, call it religion, then I don't sign up.

If I were an artist and could convey to the canvas my conceptions I would paint a monster, stalking through the Southland destroying crops, frightening farmers from the fertile lowlands to the worn-out hillsides, smashing industries and choking prosperity; displacing pleasure with misery; laying waste to 25 per cent of the school terms; supplanting childish frolic with funeral processions; I would place in his left hand the flickering taper of ignorance, in his right the wand of welfare inertia, on his head a sepulchral crown, at his feet water-soaked soil of greatest fertility, and I would give it all the title of "Malaria."

Gentlemen, go with me to the East, to the Northwest, and what do you hear of this section and other sections of the South? That we have all the advantages for the sturdy, progressive farmer, except that they fear malaria, "chills

and fever." We must remove the cause for this apprehension. We must drain malaria out by doing mosquito drainage along with the agricultural drainage; then bid the thrifty immigrants from the North, East, and West to come with their families to this land of great opportunities—and they will come.

The following paper was read and discussed in connection with Dr. Griffitts' address, and the convention requested that it be published as part of the proceedings.

MALARIA: LESSONS ON ITS CAUSE AND PREVENTION

FOR USE IN SCHOOLS

BY H. R. CARTER, Senior Surgeon, United States Public Health Service

INTRODUCTION

Teaching some of the facts about malaria in schools is not new. It was done in San Antonio in 1904 after the yellow-fever outbreak of 1903, when the writer first had cognizance of it. There are chapters on malaria and mosquitoes in most of the textbooks on hygiene used in the public schools.

This paper is, however, intended to be rather more complete than the chapters devoted to malaria in the textbooks mentioned, as the importance of the disease seems to demand. Without question, in many parts of the United States where malaria is prevalent it is more important and does more injury than all other diseases combined, and measures for its control should be emphasized. As the campaign for the control of malaria is likely to be a long one, it seems very advisable so to educate the rising generation that they may bear their full part in it. Knowledge of malaria, how it is conveyed, and how it may be controlled, if generally spread among all the people, will ultimately compel the control of malaria.

This paper was submitted to Surgeon von Ezdorf, Public Health Service, and has received the benefit of his suggestions, many of which have been adopted, and the writer only regrets that Dr. von Ezdorf's departure for Vera Cruz prevented his review of the entire paper.

I wish also to acknowledge my indebtedness to my secretary, Miss Laura A. Carter, who was really a collaborator in this work, and to Miss Ethel Neely, secretary of the Virginia Society for the Study and Prevention of Malaria, who kindly allowed me to examine a course of excellent lessons for schools prepared by herself. The arrangement of her course of lessons—questions and answers—is followed in this paper as being better for school use than a connected narrative with the questions subjoined.

These lessons, or rather this catechism, on malaria are presented, then, for use in schools, especially those in the country, either as they are written or as a basis for lessons more suitable for the different needs of the schools in different sections.

TO THE TEACHER

It was at first intended to make these lessons only for children and consequently very simple; to make them *true*, however, required either to make them less simple or to trust to the teacher to explain difficulties, and answer questions that would naturally arise. Now it may be that some of the teachers will not have sufficient knowledge of the subject to answer the questions which will be asked and give the necessary explanation—for accurate knowledge on

even the rudiments of this subject is not so common—and on this account this little paper is intended for both pupils and teachers. The questions marked (a) are intended only for the pupils. The others (b) are for the teachers, and deal with ideas a little more complex than the others, yet not especially so. They contain facts, however, which a teacher must know to understand the subject at all. Some are marked (a)? as the writer was unable to decide whether they should be marked (a) or (b).

Teachers, however, will use their own discretion in giving to pupils such of the questions intended for themselves as the age and intelligence of the class may justify.

Each school should form a field class among the pupils, studying malaria to find the larvæ of the different kinds of mosquitoes, and to identify them and to learn to recognize the different kinds of places in which they breed; where the eggs of the different families of mosquitoes may also be found and identified.

Culex mosquitoes will be found in almost any standing water, especially in rain barrels, in pools and puddles almost anywhere. *Aëdes* (*Stegomyia*) *calopus* will be found in artificial containers about houses. Anopheles will be found in the clean, shallow, shady, grassy pools described. The first two can be seen at once and recognized as not being Anopheles by their position, hanging head downwards. If one leans over a pool containing Anopheles and waits a little he will be able to see these larvæ lying flat at the surface of the water. He must wait a little, however, as they are apt to dive when one approaches them; also they frequently run to the edge and hide in the grass, so they are sometimes not so easy to see even when present. The best way to get them is with a dipper and a white saucer. *Dipping* in the water unless you see larvæ is not the best way; make a quick stroke, just skimming the water towards the edges of the pool. Carry it into the grass, because the larvæ are in the grass. Do not make this stroke until you have given the larvæ time enough after you arrived to dive and come to the top. Another way is to press the edge of the dipper suddenly under water, so that the stream of water running into it may wash the larvæ into the dipper. Pour the contents of the dipper into the saucer and you will see the larvæ against the white ground. The young Anopheles are light grey, banded with black and very slender. The older ones are red, green, black, etc., the color depending on what they eat. They are less slender. All are quick in movement, and although they will dive, yet they also dart along the surface of the water, which the others never do. Some are extremely small.

The eggs of Culex are easily recognized, being brown rafts half as large as the nail of one's little finger. The eggs are set on end in the mass. They are common on water barrels. Anopheles' eggs are in loose groups, the eggs lying flat on the water singly. They are very much harder to find and require a hand magnifying glass. They are usually demonstrated by keeping Anopheles mosquitoes in a jar with water at the bottom, on the surface of which they will deposit their eggs. Eggs may occasionally but very rarely be found in nature on the surface of water containing many very young larvæ. Dip this up in a saucer and examine with a hand glass.

Keep them in a vessel with a wide mouth—fruit jar, candy jar, etc.—half full of water or less, with pieces of grass in it extending above the water. Cover it with mosquito netting and some of them will develop into mosquitoes, and you can tell the kind. The larvæ are cannibals, and the big ones eat the others. Anopheles are much harder to raise than Culex, and unless one starts with nearly full-grown Anopheles larvæ or pupæ it is difficult to develop the mosquitoes from them unless one takes a pan or trough and makes enough of a marsh to imitate natural conditions. Some of the points of difference of mosquitoes and larvæ can be seen with the naked eye, but a good hand lens is of great assistance and makes the study much more attractive.

The pupils should be encouraged to do such antimalarial work as is practicable to them. That directed against mosquitoes is the most practical; compositions on subjects connected with the lessons; verbal reports—say, weekly—during the malarial season of what each one has done in the way of antimalarial work will increase the interest in this subject. The fuller the knowledge the teacher has of the subject, and the more it is explained and developed the more the pupil will be interested and will profit.

MALARIA

SECTION I.—MALARIAL FEVER AND ITS CAUSE

(a) Q. *What is malarial fever?*

A. A disease of man, common in hot, wet countries.

(a) Q. *What is malarial fever sometimes called?*

A. Chills and fever, bilious fever, swamp fever.

(a) Q. *Is this disease found in the United States?*

A. Yes. Along the coastal plain from Connecticut to Texas, over nearly all of the Mississippi Valley, and in a number of valleys on the Pacific coast.

(a) Q. *What causes malarial fever?*

A. The presence of certain small organisms in the blood of the person who has the fever.

(a) Q. *What do you mean by an "organism"?*

A. Something that is alive and thus has the power to reproduce its kind. It may be alive as a plant is alive, or alive as an animal is.

(a) Q. *Is the organism which causes malarial fever a plant or an animal?*

A. It is an animal, and in the blood is said to be an animal parasite.

(a) Q. *What do you mean by a "parasite"?*

A. An animal or plant that lives at the expense of another, like the mistletoe, love vine, rust on corn, or the hookworm, flea, etc. The malarial parasite lives in man only by feeding on the blood cells of the man.

(a) Q. *How do you know that these parasites are found in the blood of those who have malarial fever?*

A. Because with the microscope we can see them in the red blood cells of a man sick with malarial fever.

(a) Q. *What do you mean by red blood cells?*

A. They are very small bodies floating in the blood, shaped much like a biscuit, with thickened edges; they give the blood its red color, and are a most important part of it. They are essential to life.

HOW MALARIAL FEVER IS TAKEN

(a) Q. *How do these malarial parasites get into the blood?*

A. In one way only: Through the bite of a mosquito. Malaria is not acquired by eating improper food, by drinking bad water, by bathing in the sun, or in any other way than by the bite of a mosquito. True, if one already *has* malaria, that is, *has these parasites already in his blood*, doing these things will develop it—"bring it out"—so that he may have a malarial attack which he could otherwise escape, but only if he is *already* infected with malaria.[1]

(a) Q. *Do all kinds of mosquitoes transmit malarial parasites to man?*

A. No, only Anopheles mosquitoes carry malaria, and only some kinds of Anopheles.[2]

[1] The teacher should here tell the class of the conveyance of malaria to Dr. Patrick Manson, Jr., in London, by mosquitoes infected in Italy and brought thence to London, of the experiments of Sambon and Low at Ostia, living all summer in a screened house and keeping well, although drinking the same water and eating the same food, and in all respects except housing living like their neighbors; and give them other evidence as may be necessary to show that malaria is conveyed only by the mosquito.

[2] Classification of Howard, Dyar, and Knab.

(a) Q. *Are mosquitoes born with this power of conveying malaria?*

A. No. They acquire it only by biting a man who has these parasites in his blood. The parasites are taken then from a man by a mosquito and go back from the mosquito to another man. Where the parasites first started we do not know.

(a) ? Q. *How, then, does malaria spread?*

A. Exactly like yellow fever. A female mosquito of a certain kind feeds on a man infected with malaria and sucks up blood with malarial parasites in it. She can not convey malaria to those whom she bites for some days (a week or more) after this, but after waiting a while (the reason for which will be told later) she injects these parasites into other men whom she bites and infects them with malarial fever.

(a) Q. *What, then, is necessary to spread malarial fever?*

A. Anopheles mosquitoes; malarial parasites and healthy men. The parasites may be either already in the infected mosquitoes or in infected men, from whom the mosquitoes can get them by biting.

How to Tell Malarial Mosquitoes

(a) Q. *Do both male and female mosquitoes bite?*

A. No. The female bites. It is doubtful if the male ever bites.

Q. *Can you describe the head of a mosquito?*

A. All mosquitoes have a bill and two *palpi* (*pal-pee*), which lie close to it, one on each side. Outside the palpi are two *antennæ (an-ten-nay)* which spread apart. The antennæ of the male are plumelike. Those of the female are not.

Q. *How then can you tell the male from the female?*

A. The male has "plumes on his head."

Q. *How can you tell the Anopheles, malaria-bearing, mosquitoes from the Culex and other kinds in the United States which do not convey malaria?*

A. One way is by their heads. Anopheles have straight bills and palpi nearly as long as their bills. The females of the other kinds have short palpi, except one kind which has a curved bill. The males of both Culex and Anopheles have long palpi, and one can not tell the species of the males in this way.

(a) Q. *Are there any other differences?*

A. The malarial mosquito is slight and graceful. The wings are generally spotted or dusky.

(a) Q. *Is there any other difference to note?*

A. Yes. The way of resting on a wall. Anopheles rests in a straight line, frequently standing on her head. The others rest "humped up." This is the only way that can be used to tell the live mosquito, and is the one usually used in practice.

(a) Q. *Can you tell something of her habits while feeding—on man, I mean?*

A. She rarely bites in the daytime in the United States. The day mosquito of the South is *Aedes* (or *Stegomyia*) *calopus*—the yellow-fever mosquito. Anopheles is shy and easily driven off, and will rarely bite one who is moving about, hence is most apt to bite one who is asleep. Her bite is less painful than that of other mosquitoes, and she does not sing so loudly. On this account, when mosquitoes are much complained of they are rarely Anopheles, and there can be many Anopheles about without much complaint.

Breeding of Mosquitoes.

(a) Q. *Where do these mosquitoes breed?*

A. In water—in still water and in the pools and grassy edges of running water.

(a) Q. *How do these mosquitoes breed?*

A. They lay their eggs on the surface of the water. These eggs float, and in a few days hatch into larvæ, or "wiggle-tails." These live in the water, and in time turn to pupæ, or "tumblers," which turn into mosquitoes. There are four changes in the development of mosquitoes just as for butterflies; the eggs for both; the larvæ in place of the caterpillars; the pupæ in place of the crysalis, and the mosquitoes in place of the butterflies. For mosquitoes all these changes must take place in water, and for Anopheles will take from 12 to 16 days in summer weather—longer in cool weather.

(a) Q. *Can one tell the larvæ of Anopheles?*

A. Yes. The Anopheles larva lies at the top of the water and parallel to it, for all the world like a basking pike. The larvæ of other mosquitoes hang from the top, head downward. If the latter are touched, they will always dive. If the Anopheles larva is touched, while it may dive it will generally "scoot" backwards along the top of the water. They are not a bit alike, and once seen no one will ever mistake one for the other.

Q. *Is it important to recognize the larvæ of Anopheles?*

A. Yes; it is far more important to recognize the larvæ of Anopheles than the mosquitoes themselves, because this enables us to find their breeding places and hence to destroy them.

(a) Q. *In what kind of places do Anopheles breed?*

A. They prefer to breed in *clean* water, in small, shallow, shady pools with grassy edges; if with grass growing in them, so much the better. A marshy piece of ground with many small pools, among bullrushes and sedge, is an ideal place. The grassy edges and quiet pools formed by obstruction on small streams are also favorite places, as are cattle tracks. They have no objection to running water unless running swiftly.

(a) Q. *Do they breed in such places only?*

A. They *occasionally* breed in almost any collection of water, unless it is very foul; shallow wells, water barrels, tin cans, etc., especially if they have leaves or grass in them or the green algæ—"frog moss." Generally, however, they avoid barrels, cans, and other artificial containers unless they have grass, moss, etc., in them.

(a) Q. *How long must a pool last to breed Anopheles?*

A. Since it takes usually about 14 days for the egg to produce the mosquito, if a collection of water dries up completely in less than 14 days, it is not apt to breed mosquitoes.

MALARIAL PARASITES IN MAN.

(a) Q. *When a mosquito injects malarial parasites into a man's blood what becomes of them?*

A. The parasites which she injects enter the red blood cells. They are then extremely small. They grow by feeding on the blood cells and get bigger and bigger. Then their edges become scalloped. Then they divide into a number of wedge-shaped pieces, meeting in the middle something like the slices of a pie. Then the blood cells break up and set the young parasites free, and each one of them starts off as a new parasite on its own account and tries to enter another red blood cell and repeat the process of its mother parasite.

(a) Q. *Into how many parts does a parasite divide?*

A. Into from eight to as many as 24 or 32, according to the kind, so they may increase very rapidly.

(b) Q. *Are there different kinds of parasites?*

A. Yes; there are at least three kinds, each of which produces a different form of malarial fever.

(b) Q. *How long does it take from the time the parasites enter a red blood cell until they divide into daughter parasites?*

A. It depends on the kind of parasite. One kind, the *tertian*, takes about 48 hours, or two days. Another, the *quartan*, 72 hours, or three days. A third, the *estivo-autumnal*, from about 24 to 48 hours. This last form is much less regular in its time than the other two; indeed, two different forms may be included under this name. It produces the worst kinds of malarial fever.

(b) Q. *What causes the chill and fever of the man with malaria?*

A. When the infected red blood cells break up they liberate not only the bunch of daughter parasites, but a small amount of poison which the parasites have formed, and, when a large number of them do this at the same time, this causes the chill and fever of the sick man, which occur just after the cells break down. It has been estimated that at least 150,000,000 of parasites must divide at the same time to liberate enough poison to produce a chill—generally many more than this.

(a) *?* Q. *Do all parasites in the red blood cells divide into others, as you have described?*

A. No. Besides the sexless forms which divide and produce chills there are two other forms of malarial parasites in the blood cells. These are the male and female forms of the parasites. These do not seem to affect the health of the man in whose blood they exist, but it is by means of these that the mosquito becomes infected when she sucks them up.

(a) *?* Q. *How does the mosquito become infected with malarial parasites?*

A. By biting a man who has these male and female parasites in his blood. If she sucks up both kinds—male and female—she may become infected.

(a) *?* Q. *What takes place then?*

A. If the mosquito sucks up only sexless parasites with the blood she will not become infected, no matter how many she takes. If, however, the proper kind of mosquito takes up the male and female forms of the parasite they join together in her stomach and pass into her stomach wall, where they grow. After some time the bodies thus formed break and set free many young parasites, some of which finally find their way to the mouth of the mosquito. There the parasites are mixed with her saliva and are injected into a man when she bites him; then they enter the blood cells and start their life all over again.

(a) *?* Q. *How long does this change take?*

A. From 7 to 14 days in the summer. It takes longer in cool weather than in hot.

(a) *?* Q. *Is the mosquito dangerous to man until this change is completed?*

A. No. Until the parasites reach her saliva the mosquito cannot inject them into the person she bites. She is not dangerous, even if she has bitten a man with malarial fever, until the time necessary for this to happen has passed.

(a) Q. *Do the parasites growing in the mosquito make her sick, as they do a man in whom they grow?*

A. No. The mosquito seems to be as well as ever.

SECTION II.—PREVENTION OF MALARIA.

(a) Q. *Can malarial fever be controlled or prevented?*

A. Yes.[1]

[1] The control of malarial fever is a very different problem from its elimination or getting completely rid of it. The methods of work necessary to do this are simple, but to carry them out may well be beyond the economic limit allowable. To control it, however, that is to so lessen its amount that it does little injury in a community, is much oftener possible. It is at last a question of economics.

(a) Q. *What can be done to lessen or get rid of it?*

A. There are several methods which can be used.

First. By getting rid of the Anopheles mosquitoes which carry it.

Second. By not letting these mosquitoes get to well people to bite them.

Third. By so treating men having malarial parasites in their blood that they will not infect the mosquitoes.

Fourth. By so protecting healthy people that even if they are bitten by infected mosquitoes they will not develop malarial fever.

FIRST METHOD—GETTING RID OF ANOPHELES.

(a) Q. *How do you get rid of Anopheles?*

A. By destroying their shelters and their breeding places.

(1) DESTRUCTION OF SHELTERS

(a) Q. *What do you mean by their shelters?*

A. Anopheles live mainly out of doors, and as they can not bear the hot sun they shelter themselves in the brush and high weeds all day and come out at dusk to feed.

(a) Q. *What should be done to these shelters or hiding places?*

A. All brush and high weeds near one's house should be cut down so that mosquitoes cannot shelter themselves close to it.

(a) Q. *What should be done with the brush about their breeding places?*

A. This should also be cut down.

(a) Q. *Why?*

A. First. So we can see the breeding places to destroy them.

Second. So the sun can get in and dry up some of the breeding places.

Third. The less brush left to shelter mosquitoes the better, for if they are exposed to the hot sun many of them die.

(2) DESTRUCTION OF BREEDING PLACES

(a) Q. *How do you destroy their breeding places?*

A. In two ways: (1) By draining or filling up the pools, marshes, etc., in which they breed. (2) By oiling such pools as we can not drain or fill.

(a) Q. *How does drainage or filling up pools prevent breeding?*

A. By leaving no water in which they can breed.

(a) Q. *How does oiling the pools prevent breeding?*

A. It kills the larvæ.

(a) Q. *How does it kill the larvæ?*

A. The oil forms a layer on the surface of the water. Now, the larvæ must have air to breathe even if they do live in the water, and they come to the top to get it, and as they cannot get through this layer of oil to get air they die. Try it on a water barrel with wiggle-tails and see.

(b) Q. *How often should this oiling be done?*

A. Once in 12 or even 14 days would be often enough, but it is best done once a week on the same day of the week, so that it will not be forgotten. Use enough oil (coal oil or kerosene) to form a layer all over the surface, so that you can see it.

(a) Q. *Can all pools be oiled advantageously?*

A. No. If there be much grass in the pool the oil will not form a layer all over it. If the pool be large, that is a pond, the wind will blow the oil over to one side so that the surface on the other side is not covered. On large pools and grassy pools oil can not be depended on.

(a) Q. *Is there any other way besides oiling in which the water of pools, ditches, etc., can be made unfit for breeding Anopheles?*

A. Almost anything that makes the water foul and bad smelling will prevent Anopheles breeding in it, such as soapsuds, dyestuff, gas tar, refuse from mills, etc.

(a) Q. *What of water in barrels, drinking troughs, cans, etc.?*

A. Where water is often disturbed, as in chicken and horse troughs, Anopheles are not found or very rarely found; nor are they commonly found in barrels or in artificial containers of any kind, but they are sometimes, and if the water is not needed it is best to turn it out or oil it, or even put in a large amount of salt, as it *may* breed Anopheles, and *will* breed other mosquitoes, which are a nuisance even if they do not give one malaria.

(a) Q. *Have Anopheles larvæ other enemies besides man?*

A. Yes. The "top minnows" that are so abundant in some of our small, sluggish streams eat large numbers of them. In places where these minnows can get at them Anopheles larvæ are rarely found. Where there is grass or brush in the water frequently the fish can not get to the larvæ. These "top minnows" are our most efficient allies in our fight against these mosquitoes. Big fish are of little value—indeed, do harm by eating the minnows.[1]

Second Method—Preventing Access of Anopheles to Well People

(a) Q. *How do we prevent Anopheles mosquitoes getting to healthy people to bite them?*

A. (1) By screening the house. (2) By mosquito bars.

(a) *?* Q. *How should a house be screened against Anopheles?*

A. The screen should be No. 16 wire or No. 14 painted over to lessen the size of the mesh. All windows should be screened and all doors, if they are left open after dusk. All holes of all kinds by which mosquitoes can enter the house should be screened or closed, including the chimney. Screen doors should open outward. People should stay indoors after dusk, where mosquitoes can not reach them. Anopheles rarely enter a house in broad daylight. Screens with holes in them, or that do not fit tight, may do harm rather than good and be "mosquito traps."

(a) *?* Q. *How may such screens do harm?*

A. Because Anopheles mosquitoes try to *enter* a house all night long and thus have time to find the smallest opening in the screening. They try to *leave* the house at first light, and if they cannot find the way out before broad daylight they are trapped in the house and hide in dark places, closets, under the bed, etc., and thus accumulate in the house.

(a) Q. *How should mosquito bars be used?*

A. They should be of fine bobbinet, with no holes in them and *with no slit up the side.* They should not go over either the head or the foot piece of the bedstead at night, but be tucked under the mattress all around and never allowed to hang down to the floor. They give some protection, but far less than good screening.[2]

Third Method—Preventing Infection of Mosquitoes

(a) *?* Q. *How can we treat men with malarial parasites in their blood so that they will not infect mosquitoes?*

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[1] In this first method may also be noted the killing of Anopheles in dwelling houses. Sometimes after feeding at night Anopheles remain in the house, hiding in dark places. These are almost sure to again bite the people living in the house and are therefore much more dangerous than the same number out of doors. They may be killed with a "fly-swatter" or, if on the ceiling, by holding under them a small amount of coal oil in the top of a blacking box or yeast-powder can, into which they will drop. The can is to be nailed to the end of a long stick—a broom handle. Practice is required to find the mosquitoes. They look like little splinters on the wall and ceiling, but with practice this method can be made useful.

[2] How to screen houses against mosquitoes may be found in reprints of the United States Public Health Service, No. 170, Feb. 27, 1914, and No. 180, April 10, 1914.

A. In two ways: (1) By treating everyone who has these parasites in his blood until he is *cured* completely, not just partly well, to relapse later. This is the doctor's business. (2) By keeping these people in a screened house, or at least under a mosquito bar at night, as long as they have these parasites in their blood.

(a) *? Q. Do people have parasites in their blood only when they have malarial fever?*

A. No. A man may have parasites in his blood and be infective to mosquitoes which bite him and yet show no signs of sickness. People are apt to have parasites in their blood for some time—days, weeks, or even months—after an attack of malarial fever.

(b) Q. *How do you explain that?*

A. (1) It takes a large number of parasites to make enough poison to produce fever, the number differing for different people, and one may have many parasites and yet not enough to produce fever. (2) The sexless parasites which divide are the only ones which produce fever, and there may be only a moderate number of these in one's blood and yet enough male and female forms to infect mosquitoes. These last, you know, are the only forms which do infect mosquitoes.

(b) Q. *What are the people called who are well and yet are infective to mosquitoes?*

A. They are called "carriers," and spread malaria in a community just as a sick man does.[1]

FOURTH METHOD—IMMUNIZING PEOPLE AGAINST MALARIAL FEVER

(a) Q. *How can we protect the healthy men so that even if they are bitten by infected mosquitoes they will not develop malarial fever?*

A. By the use of quinine.

(a) Q. *How is this done?*

A. If quinine is taken by any one in small doses during the malarial season it will generally prevent him from having malarial fever.

(a) Q. *How much must be taken?*

A. Generally in the United States 4 to 5 grains every day will be enough. Where the fever is bad as much as 7½ grains may be necessary, but even 2½ or 3 grains a day will prevent a great many fevers. It is best taken after meals in one dose or in divided doses.

(a) Q. *Must the quinine be taken every day?*

A. No. It can be taken in larger doses, as 8 grains twice a week, or even every five days. The first plan we think is the best.

(a) Q. *Does the quinine taken in this way injure those who take it?*

A. No. It has been taken thus by many people for a number of years, and none are known to have been injured by it.

(a) Q. *Does it make the people who take it feel badly?*

A. There are a few people whom even a very small dose of quinine makes feel badly, but generally it does not. There are very few people who cannot take enough to prevent malarial fever. Sometimes when quinine makes one feel badly at first the bad feeling will disappear if he continues to take it.

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[1] There seems to be a field for especially useful work on this line in the Temperate Zone among the "carriers" and people with latent malaria during the winter when there are no active Anopheles. This method has been recently utilized (by Bass) in Bolivar County, Miss., and marked success reported. It had been previously used, and successfully, in several places in the Tropics, first by Koch at Stephansort.

It is, however, much more applicable to a temperate climate in which during the winter season there is no flight of Anopheles. If the "seed parasites" in the human carriers are destroyed during this season, the malaria parasite is eliminated from the community and malaria will, of course, disappear, unless introduced from elsewhere. The parasite has not been found to hibernate in the mosquito in middle Mississippi.

(a) Q. *What is the dose for children?*

A. About one-half as much as for grown people; less for small children.

(a) Q. *What is the best preparation for children?*

A. The tannate of quinine is much less bitter than the other preparations. Made up into chocolates it is not especially disagreeable to take. It is also less apt to make grown people feel badly than other preparations.

(a) Q. *What is the dose of the tannate of quinine?*

A. About two and one-half times as much as of the ordinary kind—the sulphate.

(a) ? Q. *Do people prevented from developing the fever by these small doses of quinine ever have parasites in their blood?*

A. Yes. Unfortunately sometimes they do. To what extent this occurs and to what extent the quinine prevents the parasites from developing in the blood is not yet determined.[1]

(b) Q. *Are all people not protected by quinine liable to develop malarial fever when bitten by an infected mosquito?*

A. No. Some men seem to be naturally *insusceptible* to malaria. They are probably very few. In other men the having had a number of attacks of malaria produces an insusceptibility, or at least a lowered susceptibility, to the disease, and they do not under ordinary circumstances develop it. We frequently find in a malarial country families in which the children are having fever, while the old people are not. They have had many attacks in past years, and are now not susceptible to malaria. Sometimes a severe accident or a spell of sickness may render them susceptible again.

(b) Q. *Is malarial fever liable to relapse?*

A. Yes. Untreated, or imperfectly treated, it is almost sure to relapse, and to relapse several or even many times. The infection frequently lasts over from one season to another, the man being well for months between the attacks. It has been known to relapse after two years' interval. Many of the attacks of fever in a malarial country are relapses and not new infections. All those that occur in the winter and up to June or July, are probably relapses.

TEN YEARS OF DRAINAGE IN NORTH CAROLINA

By Geo. R. Boyd, Senior Drainage Engineer, U. S. Department of Agriculture

The natural fertility and richness of the swamp and overflowed lands of North Carolina have long been a matter of common knowledge. The first settlers, realizing that good drainage was of prime importance, took in and cultivated only those lands which either had good natural drainage or could be easily drained artificially. The swamp and wet lands were thus left in timber, and were considered to be almost worthless until only a few years ago when lumber became so high in price that these swamps were valuable on account of the timber which grew upon them. When the timber had been removed, these swamps again were held to be of little or no value. As a matter of fact, they were an injury and a liability to the community rather than an asset, for they were breeding and harboring places for the Anopheles mosquito, which is responsible for what was once the great plague of the South, malaria. Although the richness of these swamp lands was appreciated, and their unhealthfulness was recognized, it was not possible for many reasons to undertake their reclamation on a large scale until 1909. In that

[1] Reprint No. 175, United States Public Health Service, gives a short account of the "quinine prophylaxis" of malaria.

year the State Drainage Law was passed which furnished a means for the coöperation of many landowners in draining these swamps and provided means of financing the drainage work so that the landowners could pay for the work through a period of years after the drainage had been secured. Beginning with that year, each year has seen an increasingly large number of drainage districts organized until at present there are something like two hundred districts in the various stages of organization. The Census Bureau for 1920 has been collecting information concerning drainage work throughout the United States and has issued complete preliminary reports on such work in North Carolina, so that it is now possible to determine, in a measure, just what has been accomplished during the past ten years.

The following table has been compiled from various reports issued by the Census Bureau, and includes all drainage districts which had been legally established up to 1920. In some of these districts, the construction work was completed some time ago, while in others construction may not have been started as yet.

It will be seen from this table that in the entire State there are, in round numbers, 550,000 acres of land which is almost two per cent of the area of the State included in regularly organized drainage districts; and that in Eastern North Carolina 475,000 acres is organized to secure better drainage. Of these 475,000 acres, 150,000 are improved farm lands—*i. e.*, they were in cultivation when the drainage district was organized—and 325,000 acres were either in timber or cut-over timber, or were uncultivated for some other reason, when the district was established. Putting these figures a little more concretely, it may be said that over the entire State an area slightly larger than Pender County has been organized into drainage districts, and of this acreage an area four and one-half times as large as New Hanover County is in process of being reclaimed and put into cultivation. Under ordinary conditions, the clearing up of these wet, cut-over lands goes on at the same time that the drainage system is being constructed, and since a large part of the work included in this table has been completed for some years, it is not unreasonable to conclude that a swamp area twice as large as New Hanover County has already been redeemed, and is now producing crops.

Of course the draining of even a large body of land is of little benefit to any one unless that land be capable of producing something. Fortunately, there is no question about the fertility of these lands although, naturally, some are better than others. They are universally recognized to be the richest lands in the State—and that is saying enough, for yields of many different crops have been reported in this State which have not been exceeded anywhere. In general, these drained lands will grow any kind of a crop—corn, cotton, grain, hay, potatoes, or truck crops. Some are especially adapted to specialized agriculture while others are more valuable for general and varied farming. Special crops are grown in some sections, such as strawberries in Pender and Columbus counties, where drained lands are selling around $1,000 per acre. Early Irish potatoes, followed by corn or cotton, are raised extensively in other sections. One tract of reclaimed swamp land in Beaufort County, containing about 100 acres, was rented for this year for potato growing at $100 per acre. Some of these swamp lands have been recently put in tobacco with excellent results. As a general thing, however, they are used for general farm crops, and probably more land is put in corn than in any other crop.

While it is impossible to give any figures covering the increased value of these reclaimed lands, it cannot be doubted that the total sum which has thus been added to the resources of the State is enormous. Individual instances by the hundreds could be given of increased values of land resulting from these drainage improvements, for, as far as the writer knows, every one of

SUMMARY OF PRELIMINARY DRAINAGE CENSUS REPORTS—NORTH CAROLINA, 1920*

Counties	Acreage in Organized Drainage Districts				Total Acreage in Counties	Per Cent of Acreage in Drainage Districts	Total Cost	Cost Per Acre, All Lands in Districts
	Improved Farm Lands	Timbered and Cut-over Land	Other Unimproved Land	Total				
Eastern North Carolina—								
Beaufort	24,155	24,017	11,457	59,629	537,600	11.1	$ 304,250	$ 5.10
Bladen, Columbus, Cumberland, Harnett, New Hanover, Pender, and Robeson	44,193	61,905	4,974	111,072	3,320,320	3.3	645,500	5.82
Camden Carteret, Chowan, Currituck, Greene, Jones, Lenoir, Pamlico, Tyrrell, Perquimans, Wayne, and Wilson	34,853	58,857	33,473	127,183	3,139,200	4.0	595,648	4.68
Edgecombe	4,857			4,857	325,760	1.5	30,000	6.18
Hyde	35,024	24,375	69,130	128,529	394,880	32.5	800,272	6.22
Pitt	1,760	450	3,990	6,200	401,280	1.5	77,600	12.51
Washington	4,969	29,695	3,780	38,444	209,280	18.4	334,352	8.70
Totals	149,811	199,299	126,804	475,914	8,328,320	5.7	2,787,622	5.85
Western North Carolina—								
Alexander, Burke, Caldwell, Cleveland, Davidson, Forsyth, and McDowell	17,557	21	4,988	22,566	2,033,920	1.1	173,900	7.70
Cabarrus	3,261	58	460	3,779	249,600	1.5	53,894	14.26
Catawba	2,902	133	167	3,202	261,120	1.2	99,250	31.00
Gaston	2,784	120	293	3,197	232,320	1.4	44,000	13.76
Iredell	7,509	591	579	8,679	376,320	2.3	183,725	21.18
Lincoln	955	70	575	1,600	191,360	0.9	37,000	23.10
Mecklenburg	14,367	476	2,381	17,224	382,080	4.5	115,101	6.68
Rowan	5,152	959	916	7,027	312,960	2.2	129,026	18.38
Totals	54,487	2,428	10,359	67,274	4,039,680	1.4	835,896	13.55
Other counties					18,825,600			
Totals for the State	204,298	201,727	137,163	543,188	31,193,600	1.7	3,623,518	6.67

*The figures in this table are taken from the last United States Census and the total acreage given as drained is somewhat less than the area at the present time.

these drainage districts that has had competent advisers has been successful in a large degree. To show something of the way in which these lands are being developed after drainage, and of the results that have been secured, brief extracts are given from some of the reports presented to the State Drainage Association in 1916:

BEAUFORT COUNTY.

Broad Creek District.

"The work in this district is practically complete. There is now between five and six thousand acres of new land to plant to corn this year, and there will probably be a larger amount cut down during this spring and planted next year; I believe that we will have at least twelve thousand acres of new land planted to corn next year."

Pantego District.

"I am sure that the land in that district, taken as a whole, has increased in value over 400 per cent. I know that that is a conservative estimate. There is not in that district an acre of cleared land that can be bought for less than $100. There is not an acre of woods land that can be bought for less than $30, and I can easily remember when that land was valued for taxation at 50 cents per acre, and we had not more than half of the exact acreage on the tax books."

NEW HANOVER COUNTY.

New Hanover District No. 1.

"This district has been completed about twelve months. Not only in an agricultural way are they reaping great rewards, but it has developed into a suburban territory. Homes are being built upon it. Already thirteen have gone up, each of which represents an expenditure of from two to four thousand dollars."

ROBESON COUNTY.

Back Swamp and Jacobs Swamp.

"We have had our district completed about three years. It has given very satisfactory results, and a good deal of land has been cleared in the district. Some of the land which was utterly worthless sold for $40 to $50 per acre. Before draining it was worth possibly $5 per acre. We paid our first assessment last year and had very little trouble in raising the money."

CRAVEN COUNTY.

"A large tract of land had been drained by private enterprise. I asked the value of that land and was told that it could not be bought for $100 per acre. Other undrained land nearby was selling for $10 per acre. This land, when drained, has such a deep soil that it is exceedingly productive for any number of years."

CABARRUS COUNTY.

Big Cold Water District.

"As much as seventy bushels of corn per acre has been raised on the drained land in this district without fertilizer, and an enormous crop of corn was raised on the land in this district in 1915. From the health standpoint the drainage has been a remarkable success. Malaria and chills have decreased, so the doctors say, 75 per cent. From an agricultural standpoint the drainage of this district has been a success, and the ditch has maintained itself as well as those who had favored the project had hoped in the beginning."

The Census reports show that the work in the State has cost $3,623,518, of which amount eastern North Carolina has paid $2,787,622. The State drainage law provides for the issuance of bonds covering the cost of the drainage

work, and these bonds are paid off in ten equal installments beginning three years after the date of issue. Thus the landowners have three years time in which to put their lands in shape to take advantage of the improved drainage conditions before they have to pay anything toward the cost of the work, and after that date they pay one-tenth of the cost of the work each year for ten years. Interest on these deferred payments must be paid. It is not too much to say that this work could never have been done without some such system of deferred payments, for very few of the landowners in any of these districts have had the money on hand to pay their part of the costs of the drainage work when it was done. The framers of the drainage law were so careful of the rights of both the landowners and the bond buyers that the method of financing provided by the law has proven to be very satisfactory to both. Under normal conditions there is a good market for such drainage bonds, and so far there has been very little trouble in collecting the funds necessary to pay them off, when they fall due.

A column showing the average cost per acre of the drainage works is found in the table. The figures given, although surprisingly uniform, represent only in a very general way the cost of the work to the landowners. In most of the counties given there are several drainage districts, and as the cost in any one district depends on the conditions in that district there is, no doubt, a considerable difference in the cost per acre in the various districts in any one county. Further, the costs in any one district are divided among the landowners in proportion to the benefit each receives, so that the costs to the landowner will differ materially from the average costs for the district as a whole. And, finally, in common with everything else, the costs of drainage construction work have increased a great deal during the past three years, so it is probable that the average costs shown are well below any average costs which could be obtained for similar districts at the present time. These figures are included in the table merely to bring out the fact that this drainage work has not been an expensive undertaking. Considered in the light of the profits shown by the district reports for 1916 which were quoted above, the average acreage cost for the State of $6.67, and for Eastern North Carolina of $5.85, seem insignificant indeed.

To sum up briefly what has been accomplished during the past ten years, it may be said that over a half-million acres of land have been included in drainage districts; that 350,000 acres of land which is very fertile and adapted to the growing of almost any crop, but which has hitherto been too wet for cultivation, has been or is being put into cultivation; and that a system of finance has been built up under the State Drainage Law whereby the costs of this work—amounting to more than $3,500,000—are being paid off by the landowners without hardship.

Although much has been accomplished during the past ten years, the reclamation of the swamp and overflowed lands of North Carolina can hardly be said to have started as yet. So much remains to be done that the little which has been done is valuable chiefly as an example or illustration of the benefits which may be expected from improved drainage. It has been said that there are over four million acres of swamp and overflowed lands in this State. Deducting from this amount the half-million acres already in drainage districts (which is not strictly correct as some of this half-million acres is undoubtedly high land), there still remains three and one-half million acres to be drained. To one who is familiar with the intensive and extensive agriculture as now practiced in Indiana, Illinois, and Iowa, on lands which thirty years ago needed drainage as badly as do the swamp lands of eastern North Carolina today, the vast amount of wet land which can be seen from the windows of any railroad train crossing Eastern North Carolina represents

a waste and a neglected opportunity which is little less than appalling. Unquestionably there is a need for this land, a need for the produce which it could furnish, and a need for the homes which it might support.

As has been said, this land is adapted by nature for the growing of all kinds of crops and has produced bountiful crops whenever given a chance. In addition to the wonderfully rich soil, and the long growing season, the advantage of location which these lands have with reference to markets makes them particularly attractive to the farmer. Since, under normal conditions, the local price for any farm product is the price of that product at the export shipping point, less the cost of getting the product to the export point, it follows that North Carolina farm products must always be considerably higher than the same products when marketed in States farther from the export centers. The writer has compiled the following table from the Monthly Crop Reports of the United States Bureau of Markets, showing the selling price of corn, per bushel, on the 1st of December each year since 1913 in North Carolina and in Iowa, and the average price throughout the United States:

	1913	1914	1915	1916	1917	1918	1919
North Carolina	$ 0.88	$ 0.86	$ 0.77	$ 1.10	$ 1.70	$ 1.77	$ 1.85
Iowa	.60	.55	.51	.80	1.08	1.22	1.20
Average for United States	.69	.64	.57	.90	1.28	1.36	1.35

These are the prices which the Bureau of Markets says were received by the farmers. They show that a bushel of corn was worth from 28 to 65 cents more, per bushel, in North Carolina than in Iowa, which is one of the premier corn-growing States. As this difference is based on the cost of transportation, it increases whenever freight rates increase; thus the margin increased markedly in 1917, and as the freight rates have been still further increased this year, it is probable that the difference in North Carolina's favor will be still greater in 1920. The same facts are true of the other staple crops, and this rule will continue to hold good until the railroads cease to charge for hauling freight. A market, then, at a price considerably above the average price for farm products in the United States, can be counted upon with certainty when considering the possibilities of draining these swamp lands.

In addition to the work which has been done by these various drainage districts, it is felt that two other lines of drainage improvement should be emphasized. One of these is complete drainage such as is secured by lateral open ditches or tile drains. In too many instances landowners, both in drainage districts and outside of them, are content when the surface water is removed from their lands, whereas they should be satisfied with nothing less than complete drainage. As between open lateral ditches and tile drains, tile drains are much to be preferred. The advantages of complete drainage have been well summed up by Prof. Newman, as follows:

"Drainage removes surplus water, deepens the soil, prevents too great dilution of plant food; improves the quality and texture of soils by making them porous and friable; admits air with its food-making and purifying oxygen; enables plants to stand drouth better, to send their roots deeper; it warms the soil and extends the period of plant growth; it checks winter killing of crops; crops start growing earlier in the spring and continue longer in growth in the fall; it aids in the healthful development of beneficial bacteria; seeds will germinate better in drained land; crops rot less and are more easily gathered from drained land than from land in need of drainage."

The need of tile drainage often is not recognized as such by the owner. It is probably safe to say that 60 per cent of the lands in Eastern North

Carolina could be improved by complete drainage. The need for drainage is indicated by water standing on the land after rains, by the cracking of the surface when it dries, by clods and harsh soil texture when plowed, by the growth of plants commonly found in wet places, and by the water table being near the surface of the ground. After a wet season, irregular areas in fields often show their need for drainage by slow growth and poor color of the growing crops, because the plant food has been washed away. Lands showing any of the above indications of an excess of water, though they be shown for only a short time, are in need of proper drainage. This work may be done by either individuals or by regularly organized drainage districts.

Another field of drainage reclamation which has been almost entirely neglected in North Carolina, is found in the abandoned rice fields and in the marshes along the coast. While these lands must, in general, be reclaimed by means of pumps, there is no doubt that many of them are very fertile and can be successfully drained in this way. While it is probable that the costs of reclaiming these lands will be somewhat higher than that of the swamps, which can be drained by gravity, at the same time it is felt that the development of some of them, at least, cannot be much longer delayed.

REPORT ON A PRELIMINARY EXAMINATION OF LITTLE RIVER DRAINAGE DISTRICT, PASQUOTANK COUNTY, N. C.*

By F. O. Bartel, Drainage Engineer
Prepared under the direction of S. H. McCrory, Chief, Division of Agricultural Engineering, 1921

INTRODUCTION

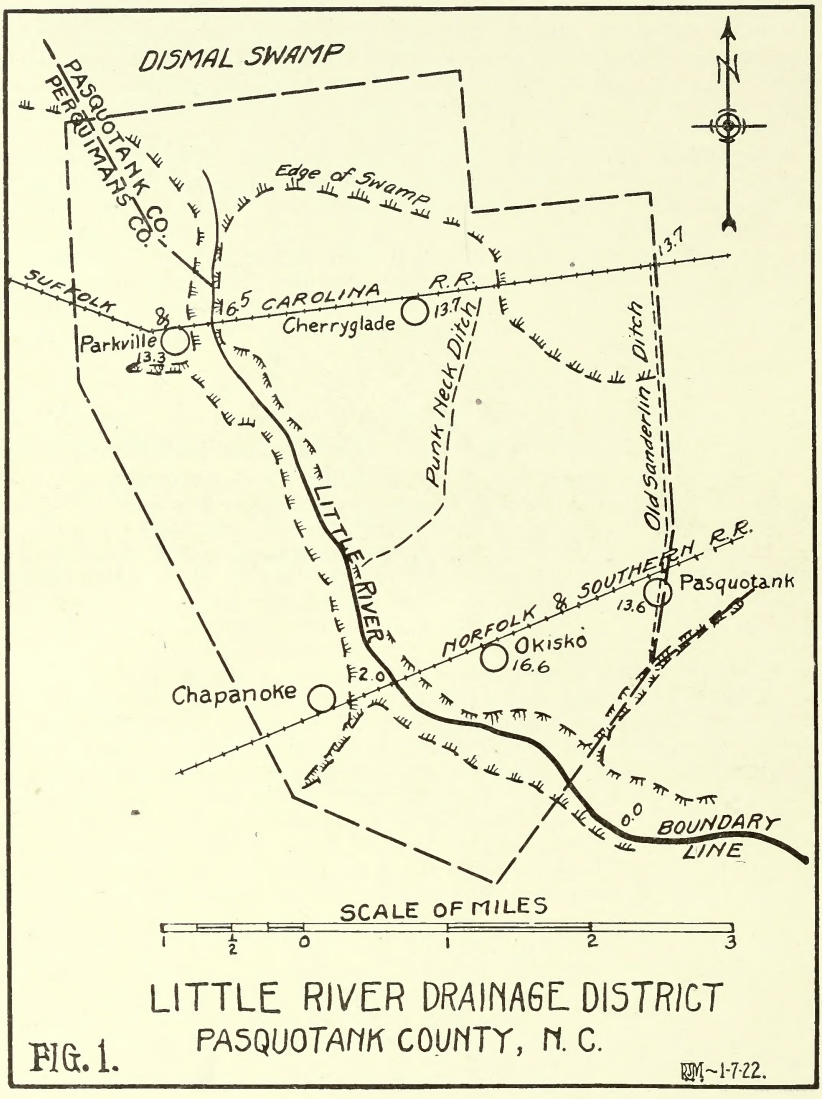
At the annual convention of the North Carolina Drainage Association held at Elizabeth City, April 12-14, 1921, Mr. T. S. Ownley, a prominent landowner of Pasquotank County, requested that an engineer from this office be sent to make a preliminary investigation of Little River, which forms the boundary line between Pasquotank and Perquimans counties, North Carolina, although such a report on this territory had been made by drainage investigations in 1909. In response to Mr. Ownley's request, Mr. H. M. Lynde, senior drainage engineer, visited the territory on May 11 and 12, 1921, but died before a report on his examination had been prepared. A third examination was then made on August 16, 1921, and the following report prepared by the writer.

The examination consisted in walking and driving about the district, gathering data and interviewing the landowners. The writer is indebted to Messrs. T. S. Ownley, H. E. Ownley, George Bright, and Wesley Foreman for information regarding conditions, and to the Norfolk Southern Railroad for elevations along its roadbed. There are about 40 landowners interested in the proposed improvement.

GEOGRAPHICAL LOCATION AND AREA

The proposed district comprises an area of about 11,000 acres, as shown on the accompanying map. It is bounded on the north by the Dismal Swamp, on the east by the Foreman plantation, and on the west by Parkville Drain-

* U. S. Department of Agriculture in coöperation with N. C. Department of Agriculture.


DISMAL SWAMP
PASQUOTANK CO.
PERQUIMANS CO.
Edge of Swamp
N
13.7
SUFFOLK
16.5 CAROLINA R.R.
Parkville
13.3
Cherryglade
13.7
PUNK NECK DITCH
Old Sanderlin Ditch
LITTLE RIVER
NORFOLK & SOUTHERN R.R.
Pasquotank
13.6
Okisko
16.6
Chapanoke
12.0
0.0
BOUNDARY LINE
SCALE OF MILES
1 ½ 0 1 2 3
LITTLE RIVER DRAINAGE DISTRICT
PASQUOTANK COUNTY, N. C.
FIG. 1.
RM.-1-7-22.

age District. Little River empties into Albemarle Sound about 13 miles below the south boundary of the district. There are no towns of more than 100 inhabitants in the district, but Elizabeth City, with a population of around 10,000, lies nine miles to the east. The district is crossed by two branches of the Norfolk Southern Railroad.

NATURAL SURFACE CONDITIONS

The run of Little River lies in a swamp bottom from about 600 to 2,000 feet wide, well defined at the lower end of the district, but hardly to be distinguished from the surrounding land above the Suffolk and Carolina Railroad. The bottom is overgrown with cypress, gum, maple, and other marsh timber, and is not more than one or two feet higher than the bottom of the stream channel. The lands back from the bottom belong to the well known Portsmouth and Norfolk series, which constitute the bulk of the agricultural land of eastern North Carolina. From what could be learned of that portion of the Dismal Swamp included in the tentative boundary lines of the district, as shown on the map, it is believed that this land has a clay subsoil and, when drained, would correspond somewhat to the Portsmouth soil that bounds it, thus differing greatly from the poor "Juniper Land" that usually lies along the edges of the Great Dismal Swamp.

It is estimated that fully 75 per cent of the land included in the district is cleared and under cultivation.

NATURAL DRAINAGE CONDITIONS

All the water that falls in the district drains to Little River. Several canals have been cut to drain the land back from the river, the most prominent being the Old Sanderlin Ditch and the Punk Neck Ditch. These are hand dug canals, shallow and poorly graded, and do little toward improving conditions further back than three-fourths of a mile from the run of the swamp. Their lack of capacity is shown by the fact that it has been found necessary to construct low dams at their upper ends to keep back the water from the Dismal Swamp, which is now taken down a small ditch along the railroad to Little River, near Parkville. The grade of this ditch and its outlet are poor and, as a consequence, the large volume of water coming down from the swamp in times of heavy rain often accumulates to a depth of a foot or more on the north side of the railroad, finds its way through culverts under the roadbed and drowns out crops on the land to the south. The land in the swamp is higher than that in the district, and near its southern extremity has appreciably more slope than toward its interior, resulting in the water from a considerable area of the swamp coming down on the district. The removal of this swamp water is one of the principal ends to be accomplished by a drainage system.

Surface elevations range from about 14 feet above sea level, in the swamp, to tide water level at the lower end of the district.

The topography is such that, except for some of the higher lands immediately adjacent to the runs, no successful drainage can be accomplished without coöperation; the need of organizing a drainage district is plainly shown. The difference in the value of crops between ordinarily dry and wet seasons, due to present poor drainage, shows that a satisfactory drainage system would pay for itself in a few years.

IMPROVEMENTS REQUIRED

The drainage of the tract appears to present no particular difficulties. The solution of the problem consists in the improvement of Little River as an outlet channel for a number of lateral ditches spaced approximately one mile apart. With this as a basis, the whole area can then be completely drained by the construction of ordinary farm drains.

It is the desire of the writer to emphasize the importance of a sufficient number of deep lateral drains. Experience has shown that in country having a topography similar to this, the land is seldom successfully drained further back than about three-fourths of a mile from the outlet channel by means of ordinary hand cut ditches.

The main collecting ditch will begin about one-half mile below the lower end of the district, and will follow in the general direction of Little River, keeping as near the center of the swamp and on as straight a course and with as easy bonds as possible. The present run of the river should be considered in laying off this main. At the upper end of the district, it will turn to the east, running parallel to the Suffolk and Carolina R. R. at a distance of one mile. There will be approximately nine miles of this canal draining a watershed of about 25 square miles. Assuming a run-off factor of one-half inch over the watershed in 24 hours, and a fall of 1.3 feet per mile, this will require a channel having a bottom width of 24 feet at the lower end of the district, narrowing to 10 feet at the Suffolk and Carolina Railroad, and to six feet at the upper end, with side slopes of one-half horizontal to one vertical. The lower six miles will average about six and one-half feet in depth, and the upper three miles about eight feet, which will require the removal of about 210,760 cubic yards of material. In addition, the run of the swamp for about one mile below the lower end should be cleared of fallen trees, logs, and other obstructions. The only practical means of cutting this canal will be with a floating dredge.

It is desirable that no farm in the district should have to go more than one-half mile to secure a good outlet; this means that the lateral outlet canals should not be over one mile apart, preferably closer than this. The best location for these canals can only be determined after a survey has been made. They should, in general, run parallel to each other and be so located as to subdivide the land to the best advantage, drainage, however, being given first consideration.

The lateral canals may be cut by either a floating dredge or by a land walking dredge. In the former case, a minimum bottom width of six feet must be used, which for a canal eight feet deep with side slopes of ½ : 1 means an excavation of 15,650 cubic yards per mile. Using a land dredge a smaller bottom width may be cut. With a four foot bottom width, which is ample, and the same depth and slopes as above, about 12,500 cubic yards per mile must be removed.

The cost of excavation with a land machine is greater, as a rule, than with a floating dredge. Estimating the former at 15 cents per cubic yard and the latter at 12 cents, the cost of constructing the laterals figures about $1,875 per mile by either method. The advantage in regard to the cost of maintenance will be with the smaller ditch, although this may be offset by a lower bid per yard on a contract requiring but one type of machine. About 11 miles of laterals will be needed.

Estimating the cost of excavation of the main at 12 cents per cubic yard we have

210,760 cubic yards at 12c	$25,291 cost of main
11 miles of laterals at $1,875 per mile	20,600 cost of lateral
or a total cost of excavation of	$45,891
Adding 10% for engineering, legal, administrative and miscellaneous expenses	4,589
we have a total estimated cost of	$50,480

for the project. As there are about 11,000 acres in the district, this will be an average cost of $4.60 per acre.

SURVEY

For the purpose of obtaining data concerning the general elevation, surface slopes, and other physical features of the district, necessary in order to lay out a satisfactory drainage system, an extended survey will be necessary. A level or transit with stadia hairs and compass attached would be a convenient instrument for most of the work.

All elevations should be referred to sea level as a datum. Level lines should be run along all the roads and railroads in the district and as many cross lines as may be necessary to obtain a thorough knowledge of the topography. All natural runs should be meandered and elevations taken along their courses. Such a survey would constitute what is known as a preliminary survey and require about one month's time for one party.

The final and complete survey would require that all ditches be staked out on the ground by setting stakes 100 feet apart, and that land lines be shown on the map.

ORGANIZATION OF DRAINAGE DISTRICTS

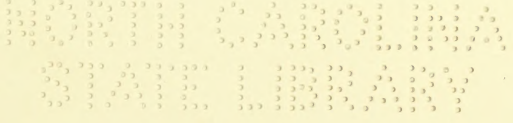
If the landowners decide to undertake the work, it is recommended that a drainage district be organized under the State law. To organize a district, a petition must be signed by a majority of the resident landowners, or the owners of three-fifths of the land in the district, and presented to the clerk of court. After the district is organized, a survey made, and engineers' report handed in showing the cost of the work, viewers are sent out to appraise damages and divide the land into five classes according to the amount of benefit it will receive. The drainage commissioners (elected by the landowners) then float a bond issue, the contract is let, and the ditches constructed.

Drainage bonds are issued in an amount covering the total cost of improvement plus a sum sufficient to pay interest on the bonds for three years following the date of issue. The bonds bear interest at the rate of six per cent annually, and are paid in ten equal installments. The first installment of principle matures in three years, and one installment thereafter for nine more years.

CONCLUSIONS

Outlet drainage can be secured for the lands discussed in this report for from $4 to $5 per acre. The best and most economical arrangement of ditches cannot be determined until a drainage survey of the area is made. The agricultural value of the land, with the possible exception of the swamp, is known; the district is already well settled and cleared, and should prove profitable for immediate development.

In addition to its importance from a strictly agricultural standpoint, drainage will be of considerable value in the improvement of health conditions, and in benefiting the roads in the district, of which there are a considerable mileage.



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